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Inshore Rockfish (*Sebastes ruberrimus, S. maliger, S. caurinus, S. melanops, S. nigrocinctus,* and *S. nebulosus*) Stock Assessment for the West Coast of Canada and Recommendations for Management

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Abstract

The available data for stock assessment is insufficient to recommend species specific catch quotas for the five management areas on the Pacific coast of British Columbia. However, this document does provides evidence of significant fishing effects on yelloweye and quillback rockfish populations at research survey index sites and other fishing locations in B.C. The level of fishing mortality at these index sites is likely indicative of inshore rockfish fishing mortality within the rockfish management region and possibly throughout B.C. Given the biology of inshore rockfish, together with the inability to assess total catch and the evidence of excessive fishing mortality, it is recommended that a portion of the rockfish population in each management area be completely protected from harvest through spatial management measures such as harvest refugia (areas closed to fishing) as a precautionary measure to promote conservation. In addition, comparable reductions in fishing effort in the remaining areas open to fishing must be accomplished or exceeded if managers choose to remain with the status quo or begin the rebuilding of stocks. Improvements to catch data, stock monitoring indices as well as stock assessment methods must continue to enable the possibility of an assessment of inshore rockfish stock status in the future.

Résumé

Les données dont nous disposons pour l'évaluation des stocks ne sont pas suffisantes pour que nous puissions recommander des quotas par espèce pour les cinq secteurs d'exploitation sur la côte Pacifique de la Colombie-Britannique. Cependant, le présent document fournit effectivement des preuves attestant d'effets importants de la pêche sur les populations de sébaste aux yeux jaunes et de sébaste épineux aux sites repères des relevés de recherche et à d'autres lieux de pêche en C.-B. Le taux de mortalité par pêche aux trois sites repères est probablement une indication de la mortalité par pêche des sébastes côtiers dans le secteur d'exploitation du sébaste et, peut-être, à l'échelle de la C.-B. Étant donné la biologie des sébastes côtiers, conjuguée à l'incapacité d'évaluer les prises totales et aux preuves de mortalité excessive par pêche, il est recommandé de protéger complètement de la pêche une portion de la population de sébaste dans chaque secteur d'exploitation par l'application de mesures de gestion spatiale comme des refuges (zones fermées à la pêche) en guise de précaution pour promouvoir la conservation. En outre, il faut réduire selon les mêmes proportions ou même davantage l'effort de pêche dans les secteurs demeurant ouverts à la pêche si les gestionnaires décident de garder le statu quo ou de commencer à reconstituer les stocks. L'amélioration des données sur les captures, des indices de surveillance des stocks et des méthodes d'évaluation des stocks doit se poursuivre si l'on veut être en mesure d'évaluer les stocks de sébastes côtiers à l'avenir.

Table of Contents

ABSTRACT 2
RESUME 3
TABLE OF CONTENTS 4
LIST OF TABLES 5
LIST OF FIGURES 7
1. INTRODUCTION 11
2. CATCH DATA 11
2.1 Coastwide Landings 11
2.2 Strait of Georgia Management Region landings 13
2.3 Catch Summary 13
3. POPULATION INDICES 13
3.1 Catch and Effort 13
3.1.2 Commercial Fishing effort 15
3.1.3 Recreational CPUE 16
3.1.4 Research survey CPUE 16
3.2 Catch and Effort Summary 17
3.3 Catch Age 17
3.4 Catch Age Summary 20
3.5 Genetic information 20
4. STOCK ASSESSMENT SUMMARY 21
5. MANAGEMENT ADVICE 23
5.2 Recommendations for management of inshore rockfish 24
6. LITERATURE CITED 26

List of Tables

TABLE 1. MINIMUM ESTIMATE OF COASTWIDE CATCH (LANDED AND RELEASED) OF YELLOWEYE ROCKFISH AND AGGREGATES 1 & 2 (QUILLBACK, COPPER, CHINA AND TIGER ROCKFISHES) IN 2000 BY FISHERY. VERIFIED LANDINGS ARE FROM DOCKSIDE MONITORING PROGRAMS AND ESTIMATED CATCHES INCORPORATE ONBOARD OBSERVER INFORMATION ON RELEASED CATCH. COASTWIDE DATA COLLECTED FOR STOCK ASSESSMENT ARE INDICATED FROM EACH FISHERY. 28

TABLE 2. REPORTED LANDINGS IN TONNES OF COMMERCIAL HOOK AND LINE ROCKFISH BY REGION AND COASTWIDE TOTAL FROM BRITISH COLUMBIA CATCH STATISTICS ANNUAL REPORTS 1956-82, SALE SLIP RECORDS 1982-1995, PACHARVHL AND PACHARV3 1995-2000. 29

TABLE 3. COASTWIDE COMMERCIAL GROUNDFISH TRAWL CATCH IN TONNES OF INSHORE ROCKFISH BY SPECIES (1996-2000) FROM OFFICIAL CATCH REPORTS PACHARVTRAWL 30

TABLE 4. ESTIMATED CATCH IN TONNES OF INSHORE ROCKFISH IN THE COMMERCIAL SHRIMP TRAWL FISHERY 1997-1999 (OLSEN ET AL. 1999). 31

TABLE 5. ESTIMATED LANDINGS OF ROCKFISH (NUMBERS OF FISH) FROM THE WEST COAST VANCOUVER ISLAND CREEL SURVEY (1999-2000) 32

TABLE 6A. ESTIMATED LANDINGS OF ROCKFISH (NUMBERS OF FISH) AND EFFORT (BOAT TRIPS) FROM THE NORTH ISLAND CREEL SURVEY 32

TABLE 6B. ESTIMATED LANDINGS BY SPECIES OF ROCKFISH (NUMBERS OF FISH) AND EFFORT (BOAT TRIPS) FROM THE NORTH ISLAND CREEL SURVEY. 32

TABLE 7. PRELIMINARY ESTIMATED LANDINGS (NUMBERS OF FISH), EFFORT (DAYS FISHED) OF ROCKFISH AND SALMON FROM THE 1999 NORTH COAST SPORTFISH REPORT. 33

TABLE 8. ESTIMATED LANDINGS (NUMBERS OF FISH) COASTWIDE FROM ALL RECREATIONAL DATA SOURCES. 33

TABLE 9. ABORIGINAL CATCH (KG) WITH BY PFMA AND MONTH FOR THE YEAR 2000, FROM BRITISH COLUMBIA CATCH STATISTICS UNIT. 34

TABLE 10A. SUMMARY OF TOTAL CATCH (KG) AND ITS DISPOSITION BY SPECIES FROM ONBOARD OBSERVER TRIPS IN THE HALIBUT LONGLINE, ZN LONGLINE AND HANDLINE FISHERIES. 35

TABLE 10B. SUMMARY OF THE INSHORE ROCKFISH CATCH (KG) AND ITS DISPOSITION BY SPECIES AND FOR ALL ROCKFISH SPECIES FROM ONBOARD OBSERVER TRIPS FOR THE HALIBUT LONGLINE, ZN LONGLINE AND HANDLINE FISHERIES. 38

TABLE 10C. WEIGHT PERCENTAGE OF INSHORE ROCKFISH CATCH LANDED BY SPECIES AND FOR ALL ROCKFISH SPECIES FROM ONBOARD OBSERVER TRIPS FOR HALIBUT LONGLINE, ZN LONGLINE AND HANDLINE FISHERIES. 38

TABLE 11. REPORTED LANDINGS (T) OF COMMERCIAL HOOK AND LINE ROCKFISH (ALL SPECIES COMBINED) FOR THE STRAIT OF GEORGIA BY STATISTICAL AREA AND FOR ALL AREAS COMBINED CATCH, FROM BRITISH COLUMBIA CATCH STATISTICS, ANNUAL REPORTS, 1954-1995. COMBINED DATA FOR 1996-2000 FROM PACHARVHL AND PACHARV3 39

TABLE 12A. ESTIMATED ROCKFISH CATCH IN NUMBERS (PIECES) BY STATISTICAL AREA FROM THE STRAIT OF GEORGIA CREEL SURVEY 40

TABLE 12B. ESTIMATED ROCKFISH FISHING EFFORT IN BOAT TRIPS BY STATISTICAL AREA FROM THE STRAIT OF GEORGIA CREEL SURVEY 40

TABLE 13. ESTIMATED RECREATIONAL CATCH IN NUMBERS (PIECES) OF SALMON AND ROCKFISH FROM THE STRAIT OF GEORGIA CREEL SURVEY (1982-2000).....41
TABLE 14A. ESTIMATED COMMERCIAL (COM) AND RECREATIONAL (REC) CATCH IN TONNES FOR THE STRAIT OF GEORGIA BY PFMA.....42
TABLE 14B. ESTIMATED COMMERCIAL (COM) AND RECREATIONAL (REC) ROCKFISH CATCH IN TONNES FOR GROUPED YEARS.....42
TABLE 15. HISTORY OF MANAGEMENT ACTIONS BY YEAR AND AREA.....43
TABLE 16. RED SNAPPER (YELLOWEYE ROCKFISH) AND OTHER ROCKFISH CATCH QUOTAS IN TONNES FOR THE FIVE MANAGEMENT REGIONS BETWEEN 1991 AND 2000.....44
TABLE 17. RECREATIONAL CATCH PER EFFORT BETWEEN JUNE AND AUGUST IN NUMBERS OF FISH (PIECES) PER 10 BOAT TRIPS FOR THE STRAIT OF GEORGIA.....45
TABLE 18. SUMMARY STATISTICS OF CATCH RATES (NUMBER OF FISH (PIECES) PER 500 HOOKS) FOR SURVEY AND LOGBOOK DATA.....46
TABLE 19A. COPPER ROCKFISH (*SEBASTES CAURINUS*) MEAN LENGTH (CENTIMETRES) AND MEAN AGE (YEARS) BY SEX, GEAR TYPE, FISHERY TYPE, MAJOR AND MINOR AREA AND YEAR. 47
TABLE 19B. BLACK, CHINA AND TIGER ROCKFISH (*SEBASTES MELANOPS, S. NEBULOSUS AND S. NIGROCINCTUS*) MEAN LENGTH (CENTIMETRES) AND MEAN AGE (YEARS) IN THE COMMERCIAL FISHERY BY SEX, MAJOR AND MINOR AREA AND YEAR.....48
TABLE 19C. QUILLBACK ROCKFISH (*SEBASTES MALIGER*) MEAN LENGTH (CENTIMETRES) AND MEAN AGE (YEARS) BY SEX, GEAR TYPE, FISHERY TYPE, MAJOR AND MINOR AREA AND YEAR. 48
TABLE 19D. YELLOWEYE ROCKFISH '*SEBASTES RUBERRIMUS*) MEAN LENGTH (CENTIMETRES) AND MEAN AGE (YEARS) BY SEX, GEAR TYPE, FISHERY TYPE, MAJOR AND MINOR AREA AND YEAR. 50
TABLE 20. ESTIMATES OF GROWTH AND TOTAL MORTALITY.....54
TABLE 21A. YELLOWEYE ROCKFISH TOTAL MORTALITY ESTIMATES (Z) AND TOTAL MORTALITY ESTIMATED OVER THE 20 TO 60 YEAR AGE CLASSES (Z_{20-60}), CATCH CURVE ANALYSIS (RICKER 1975) BY SEX.....55
TABLE 21B. YELLOWEYE ROCKFISH TOTAL MORTALITY ESTIMATES (Z) AND TOTAL MORTALITY ESTIMATED OVER THE 20 TO 60 YEAR AGE CLASSES (Z_{20-60}), CATCH CURVE ANALYSIS (RICKER 1975), BY YEAR WITH SEXES COMBINED.....55
TABLE 22A. QUILLBACK ROCKFISH TOTAL MORTALITY ESTIMATES (Z) AND TOTAL MORTALITY ESTIMATED OVER THE 12 TO 40 YEAR AGE CLASSES (Z_{12-40}), CATCH CURVE ANALYSIS (RICKER 1975) BY SEX AND YEAR.....56
TABLE 22B. QUILLBACK ROCKFISH TOTAL MORTALITY ESTIMATES (Z) AND TOTAL MORTALITY ESTIMATED OVER THE 12 TO 40 YEAR AGE CLASSES (Z_{12-40}), CATCH CURVE ANALYSIS (RICKER 1975), BY YEAR WITH SEXES COMBINED.....56
TABLE 23. GENETIC DIVERSITY IN YELLOWEYE ROCKFISH SAMPLES FROM ALASKA AND BRITISH COLUMBIA. EXPECTED HETEROZYGOSITY BASED ON OBSERVED ALLELE FREQUENCIES (H_E), OBSERVED HETEROZYGOSITY (H_O), AND ALLELIC DIVERSITY (MEAN NUMBER OF ALLELES OBSERVED PER LOCUS) ARE GIVEN FOR EACH SAMPLE.....57
TABLE 24. GENETIC DIVERSITY IN QUILLBACK ROCKFISH SAMPLES FROM BRITISH COLUMBIA AND PUGET SOUND. EXPECTED HETEROZYGOSITY BASED ON OBSERVED ALLELE FREQUENCIES (H_E), OBSERVED HETEROZYGOSITY (H_O), AND ALLELIC DIVERSITY (MEAN NUMBER OF ALLELES OBSERVED PER LOCUS) ARE GIVEN FOR EACH SAMPLE.....58

List of Figures

FIGURE 1. COMPARISON OF ANNUAL (1982-2000) RECREATIONAL A) CATCH IN NUMBERS OF FISH PER 10 BOAT TRIPS AND B) PROPORTIONS OF FISH IN NUMBERS OF SALMON AND ROCKFISH IN THE STRAIT OF GEORGIA CREEL SURVEY. 59
FIGURE 2. COMPARISON OF ESTIMATED ROCKFISH CATCH FROM THE RECREATIONAL (GREY BAR) AND COMMERCIAL (BLACK BAR) FISHERIES IN THE STRAIT OF GEORGIA MANAGEMENT REGION BY PFMA IN FOUR TIME PERIODS BETWEEN 1982 AND 2000. 60
FIGURE 3. COMMERCIAL ROCKFISH FISHERY (ZN LICENSED) YELLOWEYE ROCKFISH CPUE IN CATCH PER FISHING DAY BETWEEN 1986 AND 2000 BY MANAGEMENT REGION. SOLID LINE REPRESENTS THE MEDIAN, DOTTED LINE REPRESENTS THE 3RD QUARTILE AND DASHED AND DOTTED LINE REPRESENTS THE 1ST QUARTILE. VERTICAL DOTTED LINE SHOWS THE YEAR IN WHICH LIMITED ENTRY LICENSING WAS IMPLEMENTED. 61
FIGURE 4. COMMERCIAL ROCKFISH FISHERY (ZN LICENSED) QUILLBACK ROCKFISH CPUE IN CATCH PER FISHING DAY BETWEEN 1986 AND 2000 BY MANAGEMENT REGION. SOLID LINE REPRESENTS THE MEDIAN, DOTTED LINE REPRESENTS THE 3RD QUARTILE AND DASHED AND DOTTED LINE REPRESENTS THE 1ST QUARTILE. VERTICAL DOTTED LINE SHOWS THE YEAR IN WHICH LIMITED ENTRY LICENSING WAS IMPLEMENTED. 62
FIGURE 5. COMMERCIAL ROCKFISH FISHERY (ZN LICENSED) COPPER ROCKFISH CPUE IN CATCH PER FISHING DAY BETWEEN 1986 AND 2000 BY MANAGEMENT REGION. SOLID LINE REPRESENTS THE MEDIAN, DOTTED LINE REPRESENTS THE 3RD QUARTILE AND DASHED AND DOTTED LINE REPRESENTS THE 1ST QUARTILE. VERTICAL DOTTED LINE SHOWS THE YEAR IN WHICH LIMITED ENTRY LICENSING WAS IMPLEMENTED. 63
FIGURE 6. COMMERCIAL ROCKFISH FISHERY (ZN LICENSED) BLACK ROCKFISH CPUE IN CATCH PER FISHING DAY BETWEEN 1986 AND 2000 BY MANAGEMENT REGION. SOLID LINE REPRESENTS THE MEDIAN, DOTTED LINE REPRESENTS THE 3RD QUARTILE AND DASHED AND DOTTED LINE REPRESENTS THE 1ST QUARTILE. VERTICAL DOTTED LINE SHOWS THE YEAR IN WHICH LIMITED ENTRY LICENSING WAS IMPLEMENTED 64
FIGURE 7. COMMERCIAL ROCKFISH FISHERY (ZN LICENSED) CHINA ROCKFISH CPUE IN CATCH PER FISHING DAY BETWEEN 1986 AND 2000 BY MANAGEMENT REGION. SOLID LINE REPRESENTS THE MEDIAN, DOTTED LINE REPRESENTS THE 3RD QUARTILE AND DASHED AND DOTTED LINE REPRESENTS THE 1ST QUARTILE. VERTICAL DOTTED LINE SHOWS THE YEAR IN WHICH LIMITED ENTRY LICENSING WAS IMPLEMENTED. 65
FIGURE 8. COMMERCIAL ROCKFISH FISHERY (ZN LICENSED) TIGER ROCKFISH CPUE IN CATCH PER FISHING DAY BETWEEN 1986 AND 2000 BY MANAGEMENT REGION. SOLID LINE REPRESENTS THE MEDIAN, DOTTED LINE REPRESENTS THE 3RD QUARTILE AND DASHED AND DOTTED LINE REPRESENTS THE 1ST QUARTILE. VERTICAL DOTTED LINE SHOWS THE YEAR IN WHICH LIMITED ENTRY LICENSING WAS IMPLEMENTED. 66
FIGURE 9. COMMERCIAL ROCKFISH FISHERY (ZN LICENSED) YELLOWEYE ROCKFISH CPUE IN CATCH PER FISHING DAY BETWEEN 1986 AND 2000 IN THE STRAIT OF GEORGIA MANAGEMENT REGION BY PFMA. SOLID LINE REPRESENTS THE MEDIAN, DOTTED LINE REPRESENTS THE 3RD QUARTILE AND DASHED AND DOTTED LINE REPRESENTS THE 1ST QUARTILE. VERTICAL DOTTED LINE SHOWS THE YEAR IN WHICH LIMITED ENTRY LICENSING WAS IMPLEMENTED. 67

FIGURE 10. COMMERCIAL ROCKFISH FISHERY (ZN LICENSED) QUILLBACK ROCKFISH CPUE IN CATCH PER FISHING DAY BETWEEN 1986 AND 2000 IN THE STRAIT OF GEORGIA MANAGEMENT REGION BY PFMA. SOLID LINE REPRESENTS THE MEDIAN, DOTTED LINE REPRESENTS THE 3RD QUARTILE AND DASHED AND DOTTED LINE REPRESENTS THE 1ST QUARTILE. VERTICAL DOTTED LINE SHOWS THE YEAR IN WHICH LIMITED ENTRY LICENSING WAS IMPLEMENTED. 68
FIGURE 11. COMMERCIAL ROCKFISH FISHERY (ZN LICENSED) COPPER ROCKFISH CPUE IN CATCH PER FISHING DAY BETWEEN 1986 AND 2000 IN THE STRAIT OF GEORGIA MANAGEMENT REGION BY PFMA. SOLID LINE REPRESENTS THE MEDIAN, DOTTED LINE REPRESENTS THE 3RD QUARTILE AND DASHED AND DOTTED LINE REPRESENTS THE 1ST QUARTILE. VERTICAL DOTTED LINE SHOWS THE YEAR IN WHICH LIMITED ENTRY LICENSING WAS IMPLEMENTED. 69
FIGURE 12. COMMERCIAL ROCKFISH FISHERY (ZN LICENSED) BLACK ROCKFISH CPUE IN CATCH PER FISHING DAY BETWEEN 1986 AND 2000 IN THE STRAIT OF GEORGIA MANAGEMENT REGION BY PFMA. SOLID LINE REPRESENTS THE MEDIAN, DOTTED LINE REPRESENTS THE 3RD QUARTILE AND DASHED AND DOTTED LINE REPRESENTS THE 1ST QUARTILE. VERTICAL DOTTED LINE SHOWS THE YEAR IN WHICH LIMITED ENTRY LICENSING WAS IMPLEMENTED. 70
FIGURE 13. COMMERCIAL ROCKFISH FISHERY (ZN LICENSED) TIGER ROCKFISH CPUE IN CATCH PER FISHING DAY BETWEEN 1986 AND 2000 IN THE STRAIT OF GEORGIA MANAGEMENT REGION BY PFMA. SOLID LINE REPRESENTS THE MEDIAN, DOTTED LINE REPRESENTS THE 3RD QUARTILE AND DASHED AND DOTTED LINE REPRESENTS THE 1ST QUARTILE. VERTICAL DOTTED LINE SHOWS THE YEAR IN WHICH LIMITED ENTRY LICENSING WAS IMPLEMENTED. 71
FIGURE 14. COMMERCIAL ROCKFISH FISHERY (ZN LICENSED) CHINA ROCKFISH CPUE IN CATCH PER FISHING DAY BETWEEN 1986 AND 2000 IN THE STRAIT OF GEORGIA MANAGEMENT REGION BY PFMA. SOLID LINE REPRESENTS THE MEDIAN, DOTTED LINE REPRESENTS THE 3RD QUARTILE AND DASHED AND DOTTED LINE REPRESENTS THE 1ST QUARTILE. VERTICAL DOTTED LINE SHOWS THE YEAR IN WHICH LIMITED ENTRY LICENSING WAS IMPLEMENTED. 72
FIGURE 15. ZN OPTION A LONGLINE COMMERCIAL QUILLBACK ROCKFISH CPUE IN CATCH PER FISHING DAY BETWEEN 1995 AND 2000 FOR OUTSIDE MANAGEMENT REGIONS. SOLID LINE REPRESENTS THE MEDIAN, DOTTED LINE REPRESENTS THE 3RD QUARTILE AND DASHED AND DOTTED LINE REPRESENTS THE 1ST QUARTILE. 73
FIGURE 16. ZN OPTION B LONGLINE COMMERCIAL YELLOWEYE ROCKFISH CPUE IN CATCH PER FISHING DAY BETWEEN 1995 AND 2000 FOR OUTSIDE MANAGEMENT REGIONS. SOLID LINE REPRESENTS THE MEDIAN, DOTTED LINE REPRESENTS THE 3RD QUARTILE AND DASHED AND DOTTED LINE REPRESENTS THE 1ST QUARTILE. 74
FIGURE 17. ZN OPTION A (LIVE ROCKFISH) FISHING EFFORT (NUMBER OF SETS) SUMMARIZED BY YEAR (A, B AND C) IN 2.7 SQUARE KM GRID CELLS IN OUTSIDE MANAGEMENT AREAS. 75
FIGURE 18. ZN OPTION B (YELLOWEYE ROCKFISH) FISHING EFFORT (NUMBER OF SETS) SUMMARIZED BY YEAR (A, B AND C) IN 2.7 SQUARE KM GRID CELLS IN OUTSIDE MANAGEMENT AREAS. 78

FIGURE 19. ZN OPTION C (DEEP WATER ROCKFISH) FISHING EFFORT (NUMBER OF SETS) SUMMARIZED BY YEAR (A, B AND C) IN 2.7 SQUARE KM GRID CELLS IN OUTSIDE MANAGEMENT AREAS. 81
FIGURE 20. ZN OPTION I (STRAIT OF GEORGIA LIVE ROCKFISH) FISHING EFFORT (NUMBER OF SETS) SUMMARIZED BY YEAR (A, B AND C) IN 2.7 SQUARE KM GRID CELLS IN OUTSIDE MANAGEMENT AREAS. 84
FIGURE 21. RECREATIONAL CATCH IN NUMBERS OF ROCKFISH PER 10 BOAT TRIPS DURING JULY TO AUGUST 1982-2000 BY PFMA FROM THE STRAIT OF GEORGIA CREEL SURVEY. 87
FIGURE 22. RESEARCH SURVEY CATCH IN NUMBER OF ROCKFISH PER MINUTE OF ANGLING BY YEAR AND DEPTH INTERVAL (LEFT PANELS) AND THE CORRESPONDING CATCH AGE (RIGHT PANELS). BOXPLOTS SHOW THE MEDIAN, 1ST AND 3RD QUARTILES OF THE DATA. 88
FIGURE 23. YELLOWEYE ROCKFISH LENGTH AT AGE AND RESULTING ESTIMATES OF VON BERTALANFFY GROWTH PARAMETERS FOR MALES AND FEMALES BY INDEX SITE 89
FIGURE 24. QUILLBACK ROCKFISH ROCKFISH LENGTH AT AGE AND RESULTING ESTIMATES OF VON BERTALANFFY GROWTH PARAMETERS FOR MALES AND FEMALES BY PFMA WITHIN THE STRAIT OF GEORGIA MANAGEMENT REGION. 90
FIGURE 25. MALE YELLOWEYE ROCKFISH AGE HISTOGRAMS (LEFT PANELS) AND CATCH CURVES (RICKER 1975) SHOWING ESTIMATES OF TOTAL MORTALITY (Z) AND MORTALITY OVER THE 21 TO 60 AGE CLASSES (Z_1) FOR BOWIE SEAMOUNT AND THE INDEX SITES. 91
FIGURE 26. FEMALE YELLOWEYE ROCKFISH AGE HISTOGRAMS (LEFT PANELS) AND CATCH CURVES (RICKER 1975) SHOWING ESTIMATES OF TOTAL MORTALITY (Z) AND MORTALITY OVER THE 21 TO 60 AGE CLASSES (Z_1) FOR BOWIE SEAMOUNT AND THE INDEX SITES. 92
FIGURE 27. MALE QUILLBACK ROCKFISH AGE HISTOGRAMS (LEFT PANELS) AND CATCH CURVES (RICKER 1975) SHOWING ESTIMATES OF TOTAL MORTALITY (Z) AND MORTALITY OVER THE 12 TO 40 AGE CLASSES (Z_1) FROM RESEARCH SURVEYS IN THE PFMA 12 INDEX SITES BY YEAR. 93
FIGURE 28. FEMALE QUILLBACK ROCKFISH AGE HISTOGRAMS (LEFT PANELS) AND CATCH CURVES (RICKER 1975) SHOWING ESTIMATES OF TOTAL MORTALITY (Z) AND MORTALITY OVER THE 12 TO 40 AGE CLASSES (Z_1) FROM RESEARCH SURVEYS IN THE PFMA 12 INDEX SITES BY YEAR. 94
FIGURE 29. YELLOWEYE ROCKFISH (SEXES COMBINED) AGE HISTOGRAMS (LEFT PANELS) AND CATCH CURVES (RICKER 1975) SHOWING ESTIMATES OF TOTAL MORTALITY (Z) AND MORTALITY OVER THE 21 TO 60 AGE CLASSES (Z_1) FOR THE INDEX SITES AND BOWIE SEAMOUNT BY YEAR. 95
FIGURE 30. YELLOWEYE ROCKFISH (SEXES COMBINED) AGE HISTOGRAMS (LEFT PANELS) AND CATCH CURVES (RICKER 1975) SHOWING ESTIMATES OF TOTAL MORTALITY (Z) AND MORTALITY OVER THE 21 TO 60 AGE CLASSES (Z_1) FOR THE INDEX SITES AND BOWIE SEAMOUNT BY YEAR. 96
FIGURE 31. QUILLBACK ROCKFISH (SEXES COMBINED) AGE HISTOGRAMS (LEFT PANELS) AND CATCH CURVES (RICKER 1975) SHOWING ESTIMATES OF TOTAL MORTALITY (Z) AND MORTALITY OVER THE 12 TO 40 AGE CLASSES (Z_1) FROM RESEARCH SURVEYS IN THE PFMA 12 INDEX SITES BY YEAR. 97

FIGURE 32. QUILLBACK ROCKFISH (SEXES COMBINED) AGE HISTOGRAMS (LEFT PANELS) AND CATCH CURVES (RICKER 1975) SHOWING ESTIMATES OF TOTAL MORTALITY (Z) AND MORTALITY OVER THE 12 TO 40 AGE CLASSES (Z_1) FROM COMMERCIAL SAMPLES BY PFMA AND YEAR. 98
FIGURE 33. YELLOWEYE ROCKFISH "RELATIVE" Z_1 PLOTTED WITH ANNUAL ESTIMATES OF CATCH IN TONNES. Z_1 ARE SHOWN AS "X" FROM RESEARCH SURVEY DATA AND "O" FROM COMMERCIAL FISHERY SAMPLES, BY AREA. 99
FIGURE 34. QUILLBACK ROCKFISH "RELATIVE" Z_1 PLOTTED WITH ANNUAL ESTIMATES OF CATCH IN TONNES. Z_1 ARE SHOWN AS "X" FROM RESEARCH SURVEY DATA AND "O" FROM COMMERCIAL FISHERY SAMPLES, BY AREA. 100
FIGURE 35. NEIGHBOR-JOINING DENDROGRAM OF YELLOWEYE ROCKFISH SAMPLES BASED ON NEI'S (1972) GENETIC DISTANCE CALCULATED FROM MICROSATELLITE ALLELE FREQUENCIES. 101
FIGURE 36. NEIGHBOR-JOINING DENDROGRAM OF QUILLBACK ROCKFISH SAMPLES BASED ON NEI'S (1972) GENETIC DISTANCE CALCULATED FROM MICROSATELLITE ALLELE FREQUENCIES. 102

1. Introduction

"Inshore rockfish" refers to species of the genus *Sebastes* that inhabit rocky reefs in relatively shallow water from Alaska to California. These species include yelloweye (*S. ruberrimus*), quillback (*S. maliger*), copper (*S. caurinus*), china (*S. nebulosus*), black (*S. melanops*) and tiger (*S. nigrocinctus*) rockfish. Yelloweye and quillback rockfish are targeted species within this group, hence research and assessment is focused on these two species. What little biological data that exist on the other species are included.

This assessment of inshore rockfish compiles historic landings data, constructs catch indices from the commercial ZN fishery logbook data and uses catch age data from biological samples obtained from the commercial fishery and research surveys to estimate mortality rates (M and Z) and infer regional fishery effects on rockfish populations. The utility of catch data, population indices and research surveys in the assessment of inshore rockfish is discussed and management advice is recommended for further consultation.

Annual inshore rockfish stock assessments for the Pacific coast of Canada began in 1986 (Richards 1986). Interim assessments were conducted in 1992 to 1995 (Yamanaka and Richards, 1993b, 1994, 1995, Yamanaka 1995) and in 1999 (Kronlund et al.). Major assessments have been conducted in 1991 (Yamanaka and Richards 1992) and 1996 (Yamanaka and Kronlund 1997a). Other Pacific Scientific Advice Review Committee (PSARC) documents on inshore rockfish include Kronlund (1997) that discusses the difficulty in assessment and management, Yamanaka and Kronlund (1997b) and Kronlund and Yamanaka (1997) which review catch indices from fishery logbook records, Yamanaka et al. (2001) investigating genetic population structure of yelloweye rockfish and Kronlund and Yamanaka (2001) documenting yelloweye rockfish research surveys conducted in 1997/98 to investigate harvest impacts on populations.

2. Catch Data

2.1 Coastwide Landings

A significant obstacle to the management of rockfish fisheries throughout the northeast Pacific has been the assessment of incidental catch and the composition of the catch by species (Parker et. al. 2000). Because of the low survival rate experienced by rockfish after catch and release, all rockfish caught must be accounted for as part of the overall catch. Compiling overall catch data, which includes landed catch as well as released catch, for inshore rockfish in British Columbia is nontrivial.

Rockfishes are targeted or incidentally caught in all hook and line and trawl fisheries on the coast (Table 1.). Verified landed catch data from dockside monitoring programs is available for all commercial fisheries except salmon troll and shrimp trawl. The released catch of rockfish can be estimated for the rockfish, halibut, groundfish trawl and shrimp trawl fisheries by extrapolations from onboard observer data. Gaps still exist in onboard observer coverage of the dogfish, lingcod, sablefish and salmon by troll fisheries. Recreational landings are estimated from creel surveys conducted on individual fishers and from voluntary logbooks programs for lodges and

guides. These surveys and logbook programs are not standardized nor consistently collected on a coastwide basis, therefore comparisons between areas is difficult. The recreational catch has the potential to be large as there are on average 254,000 (between 1988 and 2000) recreational licenses issued annually in B.C. First Nations catch is not well documented on a coastwide basis. Aside from the dockside monitoring and logbook programs, identification of the rockfish catch to species is rare.

The available landings of rockfish by hook and line gear are summarized by management region in Table 2. Management regions are defined as:

a. Queen Charlotte Islands (QC) which include Pacific Fishery Management Areas (PFMAs) 1 and 2,
b. North Coast (NC) PFMAs 3 through 5,
c. Central Coast (CC) PFMAs 6 through 10,
d. West Coast Vancouver Island (WCVI) PFMAs 21 through 27 and 11 and
e. Strait of Georgia (SG) PFMAs 12 through 20, 28 and 29.

For the ZN rockfish fishery, logbook data is merged with dockside landing data to geographically partition landings by location. In 2001, the catch data for the dogfish and lingcod (Schedule II) fisheries will be handled in the same way. Between 1995 and 2000, the dockside monitoring program recorded the management region fished for only the catch of inshore rockfish species, hence the catch of other rockfish species could not be partitioned to location. Logbook data are not available for the halibut fishery hence no location or effort information can be associated with the rockfish landings. This is a significant data gap as the halibut fleet harvests about half of the total yelloweye rockfish landed (Table 1). Trawl catch is low for inshore rockfish and is shown in Tables 3 and 4 for groundfish and shrimp fisheries. Estimates of recreational catch for areas outside the Strait of Georgia are shown in Tables 5 to 8. Estimates of First Nations catch is shown in Table 9.

Onboard observer coverage for the hook and line fleet has been limited. In the halibut and rockfish fisheries 54 onboard observer trips were completed between the 1999 and 2000 fishing years. In 1999, 20 trips were conducted onboard halibut vessels and 13 trips (6 handline and 7 longline) on rockfish vessels. In 2000, 21 trips were conducted on halibut vessels. Estimates of the total catch weight and its disposition are summarized by fishery and geartype in Table 12a, inshore rockfish catch weight is summarized in Table 12b and a weight percentage of inshore rockfish landed (versus caught) is presented in Table 12c. An estimated 78% and 93% of the rockfish caught during observed trips in the halibut and rockfish fisheries are landed, respectively. An estimated 73%, 78% and 64% of the yelloweye, quillback and copper rockfish, respectively, caught during observed trips in the halibut fishery are landed.

The mortality rate suffered by discarded rockfish is unknown. Based on shallow water fishing with handline gear and holding experiments, estimates of 30% mortality rate at 1-month post catch have been made for quillback rockfish (Berry 2001). Long-term mortality rates are likely higher for these fish as visible eye damage alone was noted for 55% of the catch.

2.2 Strait of Georgia Management Region landings

Commercial hook and line rockfish landings by PFMAs within the Strait of Georgia are shown in Table 11. Recreational landings in numbers of fish (pieces), effort in boat trips and landings in weight (t) from the Strait of Georgia Creel Survey are shown in Table 12a and 12b. In recent years the annual catch in pieces per boat trip for salmon has declined since 1997 to a point where the catch rate for salmon is equivalent or less than that for rockfish Figure 1a and 1b, Table 13. Extrapolating landed catch weight data from both the Johnstone Strait and the Strait of Georgia creel surveys (multiplying pieces by 0.7 kg) and comparing these recreational landings to the commercial landings between 1982 and 2000 by PFMA, spatial trends are apparent (Figure 2). At the beginning of the time series (2a and 2b) the commercial fishery is spread throughout the area but in the later years (2c and 2d) is concentrated in the north. This change in area of catch to areas further from the traditional fishing grounds adjacent to markets may indicate stock declines in the traditional areas. Currently, the recreational fishery lands a greater proportion of rockfish in the southern portion of the Strait of Georgia management region, the Strait of Georgia proper, than the commercial fishery (Tables 14a. and 14b.).

2.3 Catch Summary

At best, the available landed catch data for inshore rockfish can be regarded as a minimum estimate of the total catch (landed and released catch). Commercial fishery landed catches are well known and the released catch of rockfish, based on onboard observer data, may be 7 to 12 % higher than the landed catch in the rockfish and halibut fisheries. Standardized programs for the collection of fishing effort and location data as well as the coastwide recording of rockfish to species are required from the recreational and First Nation fisheries. The ability to accurately estimate the coastwide total catch (landed and released catch) of rockfish by species is an integral component of assessing fishery impacts on stocks. If catch history by species were known, the resulting effect on the species stock could be assessed through fishing mortality estimates and species specific catch levels appropriate for the stock could be estimated.

3. Population Indices

3.1 Catch and Effort

3.1.1 Commercial Catch Per Unit Effort (CPUE)

The longest time series of catch data by species for inshore rockfish are from the ZN logbook records from 1986 to the present (Hand et al. 1990, Haigh and Richards 1997). These data were used to construct a time series of catch per unit of effort (CPUE) in an attempt to index population trends. In the past, logbook records have been examined for quillback and copper rockfish in the Strait of Georgia (Kronlund and Yamanaka 1997) and yelloweye rockfish on the west coast of Vancouver Island (Yamanaka and Kronlund 1997b). The utility of the ZN logbook CPUE to index inshore rockfish populations was uncertain. Fishery dependant indices are influenced to an unknown extent by the management regulations imposed on the fishery. This influence may be so great that trends in population abundance are obliterated. A brief history of management actions and Total Allowable Catch (TACs) for the ZN fishery is outlined in Table 15 and 16. Detailed management actions for the Strait of Georgia management region are

compiled and presented in Kronlund and Yamanaka (1997) and for the other outside regions in Yamanaka and Kronlund (1997b).

CPUE was derived from the weight of the catch by species per fishing day by vessel. The choice of the effort unit as a "fishing day" was done to conserve data. With the changes in the logbook over time, the majority of records previous to 1995 did not contain details of gear configuration or fishing sets as effort units. The coastwide logbook data was extracted from the PacHarvHL database (http://zoidberg/sql/).

The majority of the fishing outside of the Strait of Georgia management region is conducted with longline gear. Inside the Strait of Georgia is largely a handline fishery. For each species of inshore rockfish, trends in the median CPUE (upper and lower quartiles) are shown in Figures 3 to 8 for the longline fishery by management region and Figures 9 to 14 for the handline fishery by PFMAs 12, 13, 17, 18 and 19 in the Strait of Georgia management region. Fishing options were introduced to the ZN fishery in 1995. Median CPUE (upper and lower quartiles) are shown in Figure 15 for the option A, targeted live quillback rockfish fishery and Figure 16 for the option B, targeted yelloweye rockfish fishery. Vertical lines in each panel show the year in which limited entry was implemented.

Management changes that coincide with changes in CPUE trends are:

a) 1992 - implementation of a limited entry fishery in the Strait of Georgia management region
b) 1993 - limited entry for all other management regions.
   Limited entry reduced the number of licenses from 592 to 74 in the Strait of Georgia management region and from 1,591 to 183 for the outside regions. This management action decreased fishery wide effort and hence the CPUE index increased.
c) 1995 - change in TAC management in 1995 from "red snapper" and "other rockfish" to yelloweye and rockfish aggregates 1 to 7.
   The "other rockfish" category, which contained all rockfish species except "red snapper" (yelloweye) was split into 7 aggregates but the entire TAC for "other rockfish" was assigned only to aggregate 1 & 2 (quillback and copper rockfish). This resulted in an increase in CPUE for quillback rockfish as more effort was directed at fishing this large TAC.
d) 1991 to 2000 – Continual declines in total allowable catch (TAC).
   As with other fishery dependent catch indices, CPUE is affected by the catch, lowering TACs will lower CPUEs. Fishermen claim that decreasing TACs will result in lowered CPUE as fishing becomes more non-directed.

For immobile, reef species such as inshore rockfish, CPUE derived from data summarized over large geographic areas may not be indicative of stock abundance. Catch rates remain high as each of the reefs within the large area are consecutively fished, this 'hyper-stability' of CPUE will give no indication of declines in reef specific stocks until all reefs in the area have been fished.

3.1.1.1 Longline CPUE coastwide (Figures 3 to 8)

CPUE increased for yelloweye and quillback rockfish in 1993 (limited entry) and has tended to decline since in all regions. Catch rates are lowest in the North, Central and Strait of Georgia regions (~25 kg/day) and highest in the Queen Charlotte Islands region (~175 kg/day). An increase in CPUE in 1995 for quillback rockfish (influence of management change?) is followed by general declines since the 1993–1995 period in all the outside regions. CPUE is largely uninformative for copper, black, tiger and china rockfish as the catch is low and non-targeted.

3.1.1.2 Handline CPUE Strait of Georgia management region (Figures 9-14)

Similarly to the longline CPUE an increase in handline CPUE is seen in 1992 and 1993 (influence of limited entry?) for quillback and yelloweye rockfish, respectively. CPUE has generally declined since 1992-1993 for both species. Catch rates in 2000 for quillback rockfish increase with latitude from a 10 kg/day in PFMA 19 to 32 kg/day in PFMA 12. Again CPUE is uninformative for copper, black, tiger and china rockfish.

3.1.1.3 CPUE by fishing options A (quillback) and B (yelloweye) (Figures 15 and 16)

CPUE trends for the option A longline fishery, which targets quillback rockfish for the live market, show declines in all outside regions. Catch rates are lowest in the North and West Coast Vancouver Island regions (~50 kg/day) and highest in the Queen Charlotte Islands region (~75 kg/day). CPUE trends for the option B fishery, which targets on yelloweye rockfish, also show declines over the series. Catch rates are lower in the North and Central coast regions (~50 kg/day) and highest in the Queen Charlotte Islands region (~250 kg/day).

3.1.2 Commercial Fishing effort

3.1.2.1 Option A, B, C, and I (Figures 17 to 20)

The spatial extent of the fishing effort, by option (A, B, C and I) and year (1995 – 2000) is shown in a shaded 2.7 x 2.7 km^2 grid over the coast. Fishing effort, in the number of fishing sets has been summed within each grid cell annually. Fishing effort is spread throughout the coast and has shifted from area to area through the series. Concentrations of effort in the option A fishery have moved from the middle of the Central coast region in 1995 to the North Coast and Upper Vancouver Island areas in 1998-1999. Effort in the option B fishery peaked in 1997/1988 and has declined since. The option C fishery targets on the deep-water rockfish and is concentrated along the shelf break. Effort in the option C fishery has increased since 1997, coincident with the decline in the option B fishery. Despite the movements of the fleet, CPUE trends have declined over the time series. The option I fishery is concentrated in three general areas of the Strait of Georgia management region, Queen Charlotte Sound, Campbell River and the Gulf Islands. Areas of concentrated fishing effort have contracted in size over time and an obvious decrease in fishing effort is evident in the Gulf Island area. The decline in quillback CPUE coincides with the movement of the commercial fishing fleet out of the lower Strait of Georgia (Figure 2).

3.1.3 Recreational CPUE

3.1.3.1 Strait of Georgia (Figure 21, Table 17)

A catch index from 1982 – 2000 for the recreational fishery was constructed from numbers of rockfish per 10 boat trips for the months of June through August. Catch rates are low (1 to 4 per 10 trips) in all areas with the exception of PFMA 16 (15 per 10 trips) where the catch rate has increased steadily since 1993. This is probably indicative of a targeted recreational rockfish fishery in this area. CPUE trends from the creel survey do not reflect trends in the commercial fishery data. CPUE trends from the recreational fishery are less likely to be indicative of the population status of inshore rockfish in the Strait of Georgia. The creel survey is focused on characterizing the salmon catch. Landing sites are chosen for salmon activity, rockfish are not recorded to species and the program only extends over the salmon fishing season whereas rockfish fishing occurs year round.

3.1.4 Research survey CPUE

3.1.4.1 Yelloweye rockfish surveys

Since there were no established time series of research surveys to assess fishing influences on yelloweye rockfish populations over time, industry's knowledge of the history of the fishery was used to assess whether relative levels of historic fishing effort were detectable in present day catch rates and population demographics. Yelloweye rockfish index survey sites were established in 1997. These index sites represent contrasting levels of fishing pressure in the Queen Charlotte Islands and the upper West Coast of Vancouver Island. The Anthony Island and Top Knot areas are considered heavily fished relative to the Tasu and Triangle Island areas, respectively. Chartered commercial fishing vessels fished these sites with standardized longline gear in September of 1997 and May of 1998. Catch rates for yelloweye rockfish were lower and less variable at the heavily fished Top Knot site than the other sites (Table 18 from Kronlund and Yamanaka 2001). When viewed on a very fine spatial scale (minutes of longitude and latitude), comparable commercial fishery logbook data for the same geographic locations, showed similar patterns. Top Knot catch rates were not as large as those from the other sites. This low catch rate at Top Knot coincides with industry's perception that this area had received the heaviest fishing pressure on the coast. However, the highest catch rates in both the survey and logbook data peaked in 150 metres of depth and only depths of up to 100 metres were fished at the Top Knot site. Depth may explain some of the differences in catch rates. Results from assessing yelloweye rockfish age structure show more clearly the influence of fishing on the populations (See Catch Age).

3.1.4.2 Quillback rockfish surveys

Research surveys have been conducted for quillback rockfish in PFMA 12 since 1986 and provide the longest time series of research CPUEs and biological data. The changes in CPUE and quillback rockfish population demographics reflect the fishery influence on stocks. Hook and line jig surveys were conducted 1986, 1987, 1988 and 1992 (Richards and Hand 1987, Yamanaka and Richards 1993). Three depth intervals were fished at ten survey sites (Figure 22). Median CPUE in 1992 increased in the shallowest depth interval (1), and decreased in the medium (2) and deep (3) depth intervals. The corresponding age data shows the median age of

the quillback rockfish declined in all the depth intervals. In 1992, a large age-7, 1985 year class was recruiting to the fishery and accounting for the increase in CPUE for that year.

3.2 Catch and Effort Summary

The commercial CPUE trends for the ZN fishery show declines after the implementation of the limited entry fishery in 1992/93. If CPUE is indexing the rockfish populations, there has been a steady decline in the populations since 1992/93. Arguments can be made for the direct influence of management actions on CPUE and the alternative explanation of lowered TACs resulting in lower CPUEs over the same period. The utility of using the commercial ZN fishery CPUE as an index of rockfish abundance is limited, as the effect of management actions on CPUE cannot be independently assessed. The ZN fishery index may be further compromised with the trend towards larger proportions of the rockfish catch taken outside of the ZN fishery. The ZN CPUE series will increasingly reflect non-directed rockfish fishing and may be of little value for stock assessment.

Maps of the commercial fishing effort show annual movements of the fleet in association with declines in CPUE. This may indicate stock declines over large areas if CPUE is an index of abundance. Declines in fishing effort in the southern portion of the Strait of Georgia management region with corresponding increases in the northern portion may be indicative of stock declines in the lower Gulf Islands. Recreational CPUE is uninformative as an index of abundance as the creel survey is focused on the salmon fishery. The creel survey does, however, identify areas of targeted recreational rockfish fisheries. Research CPUE for yelloweye rockfish showed similar trends to commercial logbook CPUE on very fine spatial scales (much smaller than PFMAs). For both yelloweye and quillback rockfish, depth is an important aspect to CPUE. CPUE can be elevated by strong year classes recruiting to the fishery and cannot be differentiated without complementary catch age data.

A major impediment to inshore rockfish stock assessment is the lack of reliable abundance index or an abundance estimate. It is unlikely that an abundance index exists within the current ZN fishery data. New fishery independent methods to index abundance must be developed. Research surveys with submersibles and Remotely Operated Vehicles (ROVs) are expensive and are limited in their spatial coverage, however, these methods allow the direct assessment of inshore rockfish abundance. Using visual abundance estimates and habitat assessments, allowable biological catches (ABCs) have been estimated for the demersal shelf rockfish (DSR) fishery in southern, southeast Alaska (O'Connell et al. 1998, O'Connell and Carlile 1993). These visual methods used in conjunction with habitat and fishery CPUE indices could provide the basis for extrapolating site-specific research information to estimate relative fish abundance over much larger spatial scales. Traditional fishing indices may be used in areas where the fishery still operates and non-intrusive methods must be used in areas closed to fishing or in areas where stock rebuilding is targeted.

3.3 Catch Age

Samples collected from the commercial fishery are summarized by species and presented in Tables 19a, 19b, 19c and 19d. This data was extracted from the GFBio database (http://zoidberg/sql/). In general, individual commercial fishery samples were too small to estimate growth parameters or total mortality rates from catch curve analyses. In cases where

commercial samples were used, they were usually grouped by year, over various PFMAs or both. The larger samples and hence the most informative catch age data were obtained through research surveys at specific index sites (Richards and Cass 1987, Richards and Hand 1987, Yamanaka and Richards 1993a, Berry 2001, Kronlund and Yamanaka 2001). Estimates of von Bertalanffy growth parameters (1938) and Hoenig's (1983) total mortality (Z) for yelloweye and quillback rockfish derived from catch age data are shown in Table 20 and Figures 23 and 24.

Yelloweye rockfish range to 97 and 115 years for males and females, respectively, become vulnerable to longline gear from the age of 6 and 7 for males and females, respectively, and are then assumed to remain vulnerable for the rest of their lives. The age of full recruitment appears to be 16 years at Bowie and increases with decreasing latitude to 18 years at Tasu, Anthony Island and Triangle Island and 20 years at TopKnot. This change in age of full recruitment is related to differences in fish growth and size at age. Yelloweye rockfish size at age increases with increasing latitude. Size and age at 50% maturity ranges from 42.1 – 49.1 cm in length and 17.2 – 20.3 years of age (Kronlund and Yamanaka 2001).

Quillback rockfish range to 76 and 95 years for males and females, respectively. Full recruitment to the hook and line gear occurs at an age of 10 for quillback rockfish. Size and age at 50% maturity is 29.3 cm (95% CI 28.9 – 29.7 cm) and 11 years (95% CI 10-12 yr) (Yamanaka and Richards 1993a).

Few biological samples have been taken for black, china and tiger rockfish (Table 19b). Male mean lengths of 46, 34 and 40 cm have been recorded for black, china and tiger rockfish in B.C.

3.3.1 Age frequencies

Age frequency histograms are shown for males and females in Figures 25 and 26 (panels on the left) for the yelloweye rockfish index sites and Bowie Seamount. The high proportion of older fish at Bowie Seamount is noteworthy. The truncation of older individuals becomes more severe with decreasing latitude and is likely related to the relative fishing rates these areas have experienced (Kronlund and Yamanaka 2001).

Age frequencies histograms are shown for males and females in Figures 27 and 28 (panels on the left) for the quillback rockfish index sites in PFMA 12 in 1986-88 and 1992 and a large experimental sample collected in 2001 at similar sites to the previous surveys. The large 1978 year class, age-8 in 1986 is seen progressing through the early surveys but is not detected in the 1992 survey. A very large 1985 year class, is prominent as age-7s in 1992 and as age-16s in 2001. The truncation of the older fish, is evident in the later survey in 1992 and sample in 2001.

3.3.2 Catch curves (Ricker 1975)

Total mortality (Z) and relative mortality (Z_1) rates estimated over the 21 to 60 age range ($Z_{21\text{-}60}$) for yelloweye rockfish were estimated using catch curve analysis (Ricker 1975) and are shown for males and females collected from index sites in Figures 25 and 26 (panels on the right). Similarly, for quillback rockfish, estimates of Z and Z_1 estimated over the 12 to 40 age range ($Z_{12\text{-}40}$) were estimated and shown for males and females from research surveys in PFMA 12 (1987-88 and 1992) and the research sample 2001 in Figures 27 and 28 (panels on the right).

Female yelloweye and quillback rockfish remain in the fishery at older ages than males, therefore their Zs are lower than that for males in all areas.

Recruitment is episodic in rockfish with exceptional years occurring at a frequency of every 15 to 20 years. Variable recruitment is problematic for catch curve analysis, however, for inshore rockfish the catch curve spans up to100 years and covers may cycles of good and bad recruitment. Catch curves provide an estimate of Z based on average recruitment over the last century. The effect of good incoming recruitment will cause a steeper slope by elevating the upper end of the catch curve and bias estimates higher. This effect is indistinguishable from F>M harvests removing the older age groups in the population.

Age histograms and catch curves were constructed for combined sexes, by index site and year for yelloweye rockfish and are shown in Figures 29 and 30. Similar catch curves were constructed for quillback rockfish using all available catch age data with sample sizes greater than 200 fish, from research surveys and commercial samples by PFMA and year (Figures 31 and 32).

3.3.3 Estimates of M

Estimates of Z (Hoenig 1983) given a maximum age for yelloweye rockfish of 118 is Z = 0.0389. From catch curve analysis, the Bowie Seamount sample collected in 1999 has provided the lowest estimate of Z on the coast. Total landings of yelloweye rockfish from Bowie Seamount are estimated at about 85 t and this 1999 sample Z = 0.0195 is probably somewhat greater than the true M for yelloweye rockfish. This seamount yelloweye rockfish population is as close to "unfished" as we can get in B.C. and provides a valuable reference population or bench mark for comparison with the coastal yelloweye rockfish populations that have all experienced fishing.

Estimates of Z (Hoenig 1983) given a maximum age for quillback rockfish of 95 years is Z = 0.048. From catch curve analysis, the PFMA 12 sample of quillback rockfish in 1984 also provides the lowest estimate of Z = 0.0153 on the coast.

Natural mortality can be estimated from Z (total) = M (natural) + F (fishing) (Ricker 1975). Estimates of M for yelloweye and quillback rockfish from Z (catch curve analyses) on pre-fishery stocks (F=0) are between 0.015 and 0.02.

3.3.4 Total mortality and Fishing mortality

Catch curves for rockfish that have a lifespan greater than the historic fishery are slightly concave at the tail end of the ascending limb. This is most evident in the yelloweye rockfish catch curves where the oldest age classes have lower Zs than those exposed to a fishery for a longer period of their lives. In an attempt to compare Zs over similar periods of time, a "relative" Z_1 was estimated. This Z_1 was estimated over a 60 year period which begins after the age of full recruitment. This is for age classes 21 to 60 for yelloweye rockfish and age classes 12 to 40 for quillback rockfish.

The Z_1s are shown plotted against reconstructed catch histories for yelloweye rockfish and quillback rockfish in Figures 33 and 34. The relative Zs shown as "x" are derived from research survey data and the "o" from commercial fishery samples. Overall, relative Zs for research

survey samples are higher than those derived from commercial fishery samples (Tables 21a, 21b, 22a, and 22b). Grading practices, at either end of the age spectrum, in the commercial samples may account for some of these differences.

Historic yelloweye rockfish harvests have resulted in high relative Zs for the west side of the Queen Charlotte Islands (PFMAs 2 and 142) and the upper west coast of Vancouver Island (PFMAs 27, 127 and 111). Relative Zs at the index sites are at least twice that of the Bowie Seamount. Reconstructing past harvests to compare with resulting Zs is difficult given the lack of species specific catch (landed and released) data between 1956 and 1995.

Quillback rockfish harvests in PFMA 13 and 17-19 have resulted in high fishing mortalities as early as the mid 1980's (Figure 34). The fishery in PFMA 12 quillback rockfish began in the mid 1980's. In 2001 the fishing mortality is higher than that of the lower PFMAs in the mid 1980's. It has taken about 15 years to increase relative Zs by 3 fold in this area. Fishing scenarios were likely similar to PFMAs 13 and 17-19 where fishing history since 1970 resulted in the relative Zs of the mid 1980's. There is some evidence from surveys in 1998 in PFMAs 18 and 19 that the stock is experiencing relatively lower fishing mortalities. Similar to the yelloweye rockfish situation, reconstructing past catch is difficult given the state of the catch data, or lack thereof.

3.4 Catch Age Summary

Catch age data provide the most informative population indices, particularly those samples collected on research surveys. Research samples are standardized, particularly by depth and unbiased by grading practices in the commercial fishery.

A prudent management approach is to assume that an optimal harvest rate is less than or equal to half of the natural mortality rate, $F_{opt} \leq 0.5\ M$ (Walters and Parma 1996). Risk-neutral proxies and precautionary harvest rates (F) of 0.75 M to 0.5 M, have been recommended in the U.S. by the Scientific and Statistical Committee who sponsored a workshop (SSC 2000) to evaluate the issue and to make recommendations to the Pacific Fishery Management Council concerning the suitability of the Council's default harvest rates.

Yelloweye and quillback rockfish at index survey sites and other fishing locations along the B.C. coast have experienced harvest rates in excess of natural mortality, $F > M$ which are well above risk-neutral proxies.

3.5 Genetic information

3.5.1 Stock structure in yelloweye rockfish (Table 23, Figure 35)

Genetic analyses of 2520 yelloweye rockfish at 13 microsatellite loci were conducted in 1999-2000 (Yamanaka et al. 2001). Twenty-five samples were collected at nine sites from northwestern Vancouver Island (49.50 N 127.5 W) to southeast Alaska (57.18 N 136.07 W) and included Bowie Seamount (53.30 N and 135.60 W). All 13 loci were polymorphic in all samples with mean observed heterozygosities ranging from 0.41 to 0.89. Genetic differentiation among yelloweye samples was low; Fst values by locus ranged from 0 to 0.006, with an average value of 0.0015. Among locations Fst values averaged 0.001. Over 98% of genetic variation was

contained within yelloweye rockfish samples, with little or no significant structure accounted for by site, season of collection, phenotype (dark- and bright-coloured forms), or region of collection (west coast of Vancouver Island, west coast of Queen Charlotte Islands, Bowie Seamount and SE Alaska). Pairwise tests of allele frequencies between samples did not refute the hypothesis that all samples were drawn from a single panmictic population. The results indicate that larval dispersal in this species may be sufficient to prevent significant genetic differentiation within all of coastal B.C.

Although the genetic data provides evidence of a single 'unit stock' among yelloweye rockfish, the age composition data indicate that demographic factors vary on a much smaller spatial scale. Adult yelloweye rockfish are resident over specific rocky habitats and move little. Hence the combination of biological characteristics (longevity and sedentary behaviour) and fishery harvests, have caused detectable changes in yelloweye rockfish population parameters (Kronlund and Yamanaka 2001, Yamanaka et al. 2001). The general south to north cline of decreasing total mortality estimates is coincident with the intensity of fishing on local population structure. Heavily fished populations are characterized by a truncation of the age distribution as older individuals are removed by fishing and not replenished rapidly by adult immigration or population growth. The use of management units for yelloweye rockfish, which are geographically smaller than the single panmictic population detected is recommended.

3.5.2 Stock stucture in quillback rockfish (Table 24, Figure 36)

Analysis of gene diversity among the 19 quillback samples indicated that over 99.5% of the observed genetic variation occurred within samples and less than 0.5% of the variation accounted for by the differentiation of BC and US samples and the variability within each of those regions. The overall coancestry coefficient (F_{ST}) value was 0.004. This study provided evidence for very high levels of genetic variation within quillback rockfish aggregations and very low levels of differentiation among samples collected from throughout British Columbia. Samples collected from Puget Sound and the U.S. Strait of Georgia waters were slightly differentiated from samples in B.C. but also displayed high levels of genetic variation. The low level of sample differentiation and failure of multiple samples from the same location to consistently cluster suggests that gene flow mediated by larval dispersal, among quillback breeding aggregations throughout British Columbia is, or has been, extensive. If recent low levels of abundance have disrupted historical patterns of gene flow, it is not yet evident among mature quillback of the age groups encompassed in this study. Similar to yelloweye rockfish, the use of management units smaller in spatial scale than the entire B.C. genetic population is recommended.

4. Stock Assessment Summary

Improvements to catch data have occurred in the past and these efforts must continue. Determining the catch of rockfish to species for all fisheries coastwide is required to advance stock assessment. Onboard observer programs are required to assess the total catch (landed and released) in all commercial and recreational fisheries on the coast. Detailed fishing effort, location and catch by species, for all fisheries that catch rockfish need to be standardized and made accessible in a database for assessment purposes. Notable inclusions are the commercial halibut, recreational and First Nations fisheries.

A stock index or measure of stock abundance needs to be developed and used to monitor rockfish stock status. The establishment and monitoring of index survey sites has provided the only credible means of assessing stocks through catch age analyses. For areas that are fished, additional index sites should be established and surveyed. Methods also need to be developed in areas where fishing has been curtailed. Non-intrusive tools for monitoring rockfish stocks must be developed for use in these areas. The integration of habitat assessment with adundance estimates may provide the only method to expand biomass estimates, obtained through extensive surveys at index sites, to larger areas.

There are no means available to provide the advice management has requested in order to prosecute the current TAC based management scheme for inshore rockfish. Present stock assessments can simply document declines in populations after the fact with no capability to determine future harvest levels that will correct the situation. Given natural mortality rates in the range of 2%, harvest rates of <1% may be sustainable. Within the TAC management scheme, TACs must be set at a level where the catch is <1% of the population. Then the issue of serial depletion must be addressed. The required reduction in fishing mortality is directly related to the size of the area or number of local reef populations targeted for conservation. The smaller the area or number of populations targeted, the greater the reduction in fishing mortality required to ensure that the entire TAC does not exceed 1% of each local reef population. Since we have no method to estimate biomass over the entire coast of B.C., we cannot recommend sustainable TACs. Advice to managers, since the initiation of stock assessments in 1986, has been to incorporate a spatial component to management, whereby a portion of the population is completely protected from harvest through area closures.

The spatial management problem of inshore rockfish arises from their biology. Inshore rockfish are slow growing, late maturing, long-lived, experience good recruitment at 15 – 20 year cycles, associate exclusively with specific rocky reef habitats and as adults are sedentary. These fish are easily targeted in specific habitats that are found and revisited using modern fishing aids. Lowered TACs in all regions of the coast have not specifically addressed the localized and serial depletion problem as fishing fleets have been able to move from one localized area to another within each of the management regions. These fishery characteristics are exemplified in the fleet movements and catch age histories within the Strait of Georgia management region.

The state of rockfish stocks along the Pacific coast is largely unknown (Parker et al. 2000). This document provides evidence of population declines in yelloweye and quillback rockfish at index sites and other areas along the B.C. coast. These are only two rockfish of thirty-one rockfish species landed by hook and line gear in B.C. (AMR summary report 16 Oct 2001). Inshore, shelf (canary, silvergray, yellowtail and widow rockfish) and slope (Pacific Ocean perch, yellowmouth, redstripe, shortraker and rougheye rockfish) species that are assessed make up the bulk of the landings. Redbanded rockfish are a notable exception.

A recent stock assessment for yelloweye rockfish in 2001 for northern California and Oregon waters (Wallace 2001) show results from the Stock Synthesis model (Methot 1990) indicating that stock biomass has declined since 1970 and current spawning biomass is about 7% and 13% of the unfished spawning biomass in northern California and Oregon, respectively. Yield

projections for the next five years, under average recruitment conditions over the last 10 years, are about 8 t and 15 t annually for northern California and Oregon, respectively.

The state of Alaska manages yelloweye rockfish within a demersal shelf rockfish (DSR) TAC. TACs are set by applying a harvest rate to the estimated biomass of DSR within the Southeast Alaska region. Biomass is estimated through in-situ submersible surveys that quantify rockfish abundance and qualify rockfish habitat. In 2000, the DSR TAC was 340 t in Southeast Alaska in outside waters (TSC 2001). Of this TAC, 125 t is reserved for landed and unreported bycatch.

5. Management Advice

Given available data for stock assessment, there is no basis with which to recommend species specific catch quotas by fishery management region. As discussed, catch data are insufficient; there are no defensible population abundance indices available and no estimate of population biomass. Catch age analyses infer significant negative fishery effects on rockfish stocks. Reductions in TACs, since 1991, have had little effect at reducing the fishing rate on rockfish. Management must consider measures that will mitigate rockfish fishing mortality and stop the serial depletion of successive reefs within the large management regions. Once rockfish populations are depleted, projections of rebuilding, under no-fishing conditions, have been estimated at 25 years for yelloweye rockfish populations in Northern California (Wallace 2001).

An expansion of the TAC management scheme to include a broader based spatial management of the fishery needs to be facilitated. Because inshore rockfish are caught through targeted as well as incidental fishing activities in all hook and line and trawl fisheries on the coast, area closures are the only management measure that will restrict the catch of inshore rockfish within the area. This measure must also be coupled with a reduction of fishing effort in the open fishery that is in proportion to (or greater than) the reduction in the spatial extent of the fishing grounds. The protection of a portion of the population is the only reliable means to promote conservation of inshore rockfish. This view towards spatial management is acknowledged throughout the general science community as essential to for the conservation of Pacific rockfish (Parker et al. 2000).

Area closures were advanced by PSARC as a spatial management measure to be used in addition to traditional management strategies in previous years. Groundfish managers supported this measure in the form of "rockfish protection areas" (RPAs) where fishing rockfish is prohibited for certain groundfish fishing sectors. The existing RPAs do not restrict all fishing, are not strategically placed in all regions of the coast and probably do not encompass enough area to conserve rockfish populations.

Guidelines in the scientific literature (Yoklavich 1998) suggest the following categories for management use of rockfish harvest refugia:

1. **Heritage sites and areas for fisheries research** (less than 5 percent of the habitat).
   Goal: protection of representative essential fish habitats and key associated species. Not intended as an alternative or supplement to traditional fisheries management. Provide reference areas for researching fishing and environmental change.
2. **Buffer against overfishing** (5 to 20 percent of the habitat).
   Goal: supplement fishery management practices by providing a buffer against fishery collapse caused by failed fishery plans or unexpected natural or anthropogenic events. Provide a benchmark for management trials or experiments.
3. **Sustainable fishery management** (20 to 50 percent of the habitat).
   Goal: Harvest refugia comprise an area that is sufficient to sustain fisheries in adjacent fished areas. Large scale protection of the total area of habitat for multi-species or the spawning potential for targeted species.

The level at which conservation goals should be met for rockfish needs to be defined. Genetic evidence indicates that yelloweye and quillback along the B.C. coast make up one panmictic population. Serial depletion of successive reefs may be of no concern until the last reef is harvested if managers are to conserve genetic diversity. At the other end of the spectrum, it may be impractical to conserve every single reef population. At present, the conservation units that are practical for fishery management are the five management regions that currently exist. It is expected that within these regions, some reef populations may be lost through serial depletion but these will be weighed against conservation gains that will accrue within the areas closed to all fishing.

5.2 Recommendations for management of inshore rockfish

Inshore rockfish are one component of the multi-species catch taken from commercial, recreational, and First Nations hook and line and trawl fisheries. Managers are required to account for the catch (landed and released) by species of inshore rockfish in all of these fisheries. This task is nontrivial. Fishing mortality must be reduced to fall within accepted risk-adverse to precautionary guidelines (SSC 2000). There are no conservation gains in closing a single fishery when catch from other commercial, recreational and Aboriginal fisheries remain unmonitored and unmanaged. This is simply a reallocation of the catch as every fishery has the potential to catch rockfish. Management actions must expand beyond the control of individual fishery harvests (TACs) and integrate spatial effort controls in all areas.

The Rockfish Conservation Strategy first proposed in 1998 needs to be implemented. Components of the plan are:

1. Account for all catch (landed and released)
2. Decrease fishing mortality
3. Establish areas closed to all fishing
4. Improve stock assessment and monitoring

To advance the Rockfish Conservation Strategy, the following management measures are specifically recommended.

1. Determine rockfish catch in all commercial, recreational and Aboriginal fisheries.
    a. Require dockside monitoring programs for commercial, recreational and Aboriginal fisheries coastwide.
    b. Require logbook data from all commercial, recreational and Aboriginal fisheries.
        i. Halibut logbook data, including rockfish catches
        ii. Recreational creel survey, guides and lodges
        iii. Aboriginal subsistence and fishery allocations
    c. Require onboard observer estimates of catch compared to landings.
        i. Commercial lingcod, dogfish and salmon troll fisheries
        ii. Recreational lodges and guided operations
    d. Manage these data in databases.
        i. Groundfish fishery logbook data in groundfish databases (e.g. halibut)
        ii. Recreation and aboriginal data in regional databases
    e. Require all fishery managers to be accountable for reporting incidental catch in their fisheries.
        i. Salmon troll, shrimp trawl as well as recreational fishery managers should be responsible for providing rockfish incidental catch estimates by species for stock assessment purposes.

2. Recommend decreasing fishing effort in all areas of the coast through:
    a. Instituting harvest refugia as a buffer in 20% of the rockfish habitats in the outside areas, and
    b. Instituting harvest refugia as sustainable fishery management in 50% of the rockfish habitats within the Strait of Georgia management region, and
    c. Decreasing all rockfish catch substantially (greater than the proportion of fishing area closed) in the remaining fishing areas.

3. Account for rockfish catch (landed and released) for all commercial, recreational and Aboriginal fisheries within the Groundfish Management Unit to ensure that all rockfish catch is within the annual limits (TAC) set for each management region.
    a. Determine catch for all ZN fishery options (A, B, C, D and I) by PFMA.

4. Begin stock monitoring programs and develop population indices.
    a. Index areas should be established in all areas, both within and adjacent to harvest refugia.
    b. Monitor with research surveys and biological sampling programs
    c. Develop new non-intrusive visual methods to assess rockfish abundance
    d. Develop new methods to assess habitats.

6. Literature Cited

Berry, M. D. 2001. Area 12 (Inside) rockfish selective fishery study. SCBC Project No. FS00 – 05. Final Report prepared for Fisheries Renewal B. C. and Science Council of B.C. 20 p.

von Bertalanffy, L. 1938. A quantitative theory of organic growth. Hum. Biol. 10: 181-213.

Haigh, R. and L. J. Richards. 1997. A relational database for hook and line rockfish logbook data. Can. Manuscr. Rep. Fish. Aquat. Sci. 2408. 46 p.

Hand, C. M., J. R. Candy, and L. J. Richards . 1990. Results of the 1986-1988 Inshore rockfish log program. Can. Manuscr. Rep. Fish. Aquat. Sci. 2069: 41 p.

Hoenig, J.M. 1983. Empirical use of longevity data to estimate mortality rates. Fish. Bull. Vol 82(1): 898-903.

Kronlund, A.R. 1997. A discussion paper on reconciling assessment and management of inshore rockfish. Canadian Stock Assessment Secretariat Res. Doc. 97/137, 69 p.

Kronlund, A.R. and K.L. Yamanaka. 1997. Analysis of ZN Hook and line logbook data: Strait of Georgia management region. Canadian Stock Assessment Secretariat Res Doc 97/135, 44 p.

Kronlund, A.R. and K.L. Yamanaka. 2001. Yelloweye rockfish (*Sebastes ruberrimus*) life history parameters assessed from areas with contrasting fishing histories. P. 257-277. In Spatial processes and the management of fish populations, G.H. Kruse, N. Bex, A. Booth, M.W. Dorn, S. Hills, R.N. Lipcius, D. Pelletier, C. Roy, S. J. Smith, and D. Witherell (eds.). University of Alaska Sea Grant, AK-SK-01-02, Fairbanks.

Methot, R.D. 1990 Synthesis model: an adaptable framework for analysis of diverse stock assessment data. Bulletin of the International North Pacific Fisheries Commission 50, 259–277.

O'Connell, V.M. and D.W. Carlile. 1993. Habitat-specific density of adult yelloweye rockfish *Sebastes ruberrimus* in the eastern Gulf of Alaska. Fish. Bull. U.S. 91:304-309p.

O'Connell, V.M., D.W. Carlile and W.W. Wakefield. 1998. Using line transects and habitat-based assessment techniques to estimate the density of yelloweye rockfish (Scorpaenidae: *Sebastes*) in the Eastern Gulf of Alaska. ICES CM 1998/O:56.

TSC 2001. State of Alaska Groundfish Fisheries and associated investigations in 2000. *In* Technical Sub-committee of the Canada-United States Groundfish Committee, May 8-11, 2001. Working document. 27 p.

Parker, S.J., S.A. Berkley, J.T. Golden, D.R. Gunderson, J. Heifetz, M.A. Hixon, R. Larson, B.M. Leaman, M.S. Love, J.A. Musick, V.M. O'Connell, S. Ralston, H.J. Weeks, and M.M. Yoklavich. 2000. Management of Pacific Rockfish. Fisheries Vol. 25, No. 3, p. 22-25.

Richards, L. J. 1986. PSARC Working paper G86-1. 1986 assessment for commercially exploited rockfish stocks in the Strait of Georgia. Can. MS Rep. Fish. Aquat. Sci. 1885: 55 p.

Richards, L. J. and A. J. Cass. 1987. 1986 research catch and effort data on nearshore reef-fishes in British Columbia statistical area 12, 13 and 16. Can MS Rep. Fish. Aquat. Sci. 1903: 119 p.

Richards, L. J. and C. M. Hand. 1987. 1987 research catch and effort data on nearshore reef-fishes in British Columbia statistical areas 12 and 13. Can. MS Rep. Fish. Aquat. Sci. 1958: 59 p.

Ricker, W.E., 1975. Computation and interpretation of biological statistics of fish populations. Bull. Fish. Res. Board Can. 191: 382 p.

SSC. 2000. Scientific and statistical committee statement on default maximum sustatinable yield fishing rate within the harvest rate policy. Supplemental SSC Report D.13.(2). June 2000 14 p.

Wallace, F.R. 2001. Status of the yelloweye rockfish resource in 2001 for Northern California and Oregon waters. In Appendix to the Status of the Pacific Coast Groundfish Fishery Through 2000 and Recommended Acceptable Biological Catches for 2002 Stock Assessment and Fishery Evaluation. Pacific Fishery Management Council 7700 NE Ambassador Place Portland, Oregon 97220-1384

Walters, C., and A. M. Parma. 1996. Fixed exploitation rate strategies for coping with effects of climate change. Can. J. Fish. Aquat. Sci. 53:148-158.

Yamanaka, K.L. and L.J. Richards. 1992. Inshore Rockfish. p. 221-266 *In* Leaman, B.M. [Ed.}. Groundfish stock assessments for the west coast of Canada in 1991 and recommended yield options for 1992. Can. Tech. Rep. Fish. Aquat. Sci. 1866:304p.

Yamanaka, K.L. and L. J. Richards. 1993a. 1992 research catch and effort on nearshore reef-fishes in British Columbia Statistical Area 12. Can. Manuscr. Rep. Fish. Aquat. Sci. 2184: 77 p.

Yamanaka, K.L. and L.J. Richards. 1993b. Inshore Rockfish. p. 336-359 *In* Leaman, B.M. and M. Stocker [Eds.}. Groundfish stock assessments for the west coast of Canada in 1992 and recommended yield options for 1993. Can. Tech. Rep. Fish. Aquat. Sci. 1919:407p.

Yamanaka, K.L. and L.J. Richards. 1994. Inshore Rockfish. p. 317-338 *In* Stocker, M. [Ed.}. Groundfish stock assessments for the west coast of Canada in 1993 and recommended yield options for 1994. Can. Tech. Rep. Fish. Aquat. Sci. 1975:352p.

Yamanaka, K.L. and L.J. Richards. 1995. Inshore Rockfish. p. 394-422 *In* Stocker, M. and J. Fargo [Eds.}. Groundfish stock assessments for the west coast of Canada in 1994 and recommended yield options for 1995. Can. Tech. Rep. Fish. Aquat. Sci. 2069:440p.

Yamanaka, K.L. 1995. Inshore Rockfish stock assessment for 1995 and recommended yield options for 1996. PSARC Working Paper G95-11.

Yamanaka, K.L. and A.R. Kronlund. 1997a. Inshore rockfish stock assessments for the west coast of Canada in 1996 and recommended yield options for 1997. Can. Tech. Rep. Fish. Aquat. Sci. 2175: 80 p.

Yamanaka, K.L. and A.R. Kronlund. 1997b. Analysis of longline logbook data for the west coast Vancouver Island yelloweye rockfish fishery. Canadian Stock Assessment Secretariat Research Document 97/134 41 p.

Yamanaka, K. L., R. E. Withler and K. M. Miller. 2001. Structure of Yelloweye Rockfish (*Sebastes ruberrimus*) Populations in British Columbia. Canadian Stock Assessment Secretariat Research Document 2000/172 32 p.

Yoklavich, M. M. (Ed.). 1998. Marine harvest refugia for west coast rockfish: A workshop. NOAA Technical Memorandum 225. 159p.

Table 1. Minimum estimate of coastwide catch (landed and released) of yelloweye rockfish and Aggregates 1 & 2 (quillback, copper, china and tiger rockfishes) in 2000 by fishery. Verified landings are from Dockside Monitoring Programs and estimated catches incorporate onboard observer information on released catch. Coastwide data collected for stock assessment are indicated from each fishery.

Licence Category	Description of fishery	Yelloweye (t)		Aggs 1&2 (t)		Coastwide data collected		
		verified landings	estimated Catch *	verified landings	estimated Catch *	landings	Logbooks Cpue/loc	observers catch
L	Halibut	220.8	301.2	10.8	13.9	DMP	No	<1%+
ZN	Hook&line rockfish	229.0	237.8	277.7	316.3	DMP	1986+	<1%+
T	Groundfish trawl	7.8	16.9	4.5	12.6	DMP	No	100%+
C	Lingcod & dogfish	0.2	0.2	0.1	0.1	DMP	2001+	0%
K	Sablefish	0	0	0	0	DMP	Yes	0%
S	Shrimp trawl	0	0	0	0	No	Yes	2%
A	Salmon troll	0.1	0.1	0.7	0.7	No	No	?
REC	Individual fishers	40.2	40.2	103.8	103.8	Creel#	No	No
	Lodges	?	?	?	?	No	Yes#	No
	Guides	?	?	?	?	No	Yes#	No
FN	Allocations	0.3	0.3	0.4	0.4	No	?#	No
	Food Fish	?	?	?	?	No	?#	No
TOTAL Landings/Catch		505.9	595.1*	404.7	446.4*			

* minimum estimate
? unknown
+ PBS Groundfish databases
# no standardized coastwide data collection

Table 2. Reported landings in tonnes of commercial hook and line rockfish by region and coastwide total from British Columbia Catch Statistics Annual Reports 1956-82, sale slip records 1982-1995, PacHarvHL and PacHarv3 1995-2000.

Year	SG	WCVI	QCI	NC	CC	UNK[1]	Total
1956	58.0	26.3	1.7	0.1	5.6		91.7
1957	86.9	45.0	9.1	0.3	5.5		146.8
1958	109.2	36.9	0.6	0.1	8.0		154.8
1959	105.0	41.7	0.8	0.0	3.6		151.1
1960	83.9	49.3	8.5	2.0	7.5		151.2
1961	69.2	59.2	3.7	0.7	11.3		144.1
1962	110.4	79.2	14.0	0.0	11.9		215.5
1963	84.2	53.9	13.3	2.8	24.2		178.4
1964	50.1	33.3	2.9	0.2	4.6		91.1
1965	43.3	27.3	10.1	1.1	4.4		86.2
1966	37.0	31.8	6.4	0.5	8.4		84.1
1967	55.6	43.4	9.4	7.3	11.3		127.0
1968	56.6	35.3	2.8	0.0	18.7		113.4
1969	82.2	45.8	10.5	0.5	46.6		185.6
1970	87.2	58.3	12.8	11.4	65.7		235.4
1971	74.5	25.6	27.2	10.2	31.4		168.9
1972	94.4	88.9	19.0	17.1	30.2		249.6
1973	100.8	48.1	14.3	15.1	20.2		198.5
1974	37.5	73.7	38.6	22.3	25.2		197.3
1975	40.3	57.3	74.7	18.9	30.4		221.6
1976	48.1	58.2	23.0	13.3	39.0		181.6
1977	138.0	100.0	35.6	14.2	25.4		313.2
1978	156.0	73.5	61.0	34.0	33.5		358.0
1979	250.0	148.0	87.0	15.5	40.0		540.5
1980	180.0	130.0	90.0	19.0	24.0		443.0
1981	211.6	102.9	71.2	13.2	14.0		412.9
1982	281.2	87.4	49.0	7.5	17.4		442.5
1983	298.7	103.2	41.6	12.4	20.2		476.1
1984	347.3	140.8	100.6	23.3	27.2		639.2
1985	436.8	198.7	155.1	40.2	57.8		888.4
1986	525.4	584.1	198.8	38.1	145.8		1491.7
1987	422.7	657.2	313.7	80.2	130.9		1604.7
1988	496.5	553.9	304.8	63.5	179.4		1598.1
1989	460.2	642.7	290.6	94.2	188.9		1676.6
1990	469.9	816.9	453.6	106.7	368.8		2215.9
1991	480.6	777.6	474.0	129.9	333.0		2195.1
1992	177.7	571.4	562.1	124.1	262.2		1697.5
1993	198.9	797.0	573.0	163.3	224.0		1956.2
1994	274.4	666.5	659.7	109.3	232.5		1942.4
1995	197.5	757.8	929.3	558.5	197.3		2640.4
1996*	186.8	561.0	480.7	84.8	187.9	410.9	2246.9
1997*	174.6	415.6	367.1	96.8	206.2	653.0	2196.9
1998*	170.3	394.2	489.8	32.7	134.6	672.1	2214.0
1999*	150.0	419.8	940.6	20.7	132.6	418.8	2302.8
2000*	141.2	351.6	860.6	63.9	134.4	129.8	2135.8

[1] Unknown areas unavailable in logbook dataset.

* Area resolution unavailable in Halibut DMP dataset, only total catch used. Area resolution available only for Yelloweye and Aggregate1&2 for Schedule II DMP dataset.

Table 3. Coastwide commercial groundfish trawl catch in tonnes of inshore rockfish by species (1996-2000) from Official Catch Reports PacHarvTrawl

		Management Region					
Species	**Year**	**CG**	**NC**	**QCI**	**SG**	**WCVI**	**Coastwide**
SEBASTES CAURINUS	1996	0.61	7.51	2.91	0.03	0.10	11.14
	1997	0.01	5.53	1.66	0.07	0.51	7.77
	1998	0.01	3.24	1.29	0.21	0.62	5.37
	1999	0.01	2.44	1.80		0.17	4.42
	2000	0.44	3.94	1.32	0.01	0.41	6.11
SEBASTES MALIGER	1996	0.52	3.56	4.61	0.16	3.27	12.11
	1997	1.10	2.24	1.46	0.03	3.20	8.02
	1998	0.66	2.08	1.14	0.02	4.55	8.44
	1999	0.89	1.76	1.20		1.98	5.83
	2000	1.34	0.86	0.67	0.10	2.09	5.05
SEBASTES MELANOPS	1996	5.83	0.37	0.07	0.04	0.22	6.53
	1997	0.87	4.59	0.02		0.10	5.57
	1998	7.01	1.16	0.07		0.07	8.31
	1999	0.46	1.72	0.01		0.03	2.22
	2000	3.45	1.07	0.03	0.00	0.04	4.59
SEBASTES NEBULOSUS	1996	0.00	0.00	0.00		0.00	0.00
	1997	0.00	0.03	0.08		0.03	0.14
	1998	0.00	0.12	0.00		0.04	0.17
	1999	0.01	0.06	0.05		0.31	0.43
	2000	0.04	0.17	0.01	0.00	0.02	0.25
SEBASTES NIGROCINCTUS	1996	0.00	0.01			0.00	0.01
	1997	0.02	0.00	0.00		0.03	0.05
	1998	0.01	0.03	0.01		0.05	0.09
	1999	0.01	0.00	0.00		0.08	0.10
	2000	0.02		0.01	0.00	0.02	0.06
SEBASTES RUBERRIMUS	1996	4.87	0.18	0.93		10.49	16.47
	1997	9.87	0.19	0.48		6.87	17.40
	1998	6.68	0.12	0.72		5.99	13.52
	1999	6.16	0.06	0.47		5.72	12.41
	2000	7.94	0.10	0.38	0.86	5.97	15.25

Table 4. Estimated catch in tonnes of inshore rockfish in the commercial shrimp trawl fishery 1997-1999 (Olsen et al. 1999).

		Management Region				
Species	**Year**	**CC & QCI****	**NC**	**SG**	**WCVI***	**Total**
SEBASTES CAURINUS	1997	0.00	2.95	0.06	0.00	3.01
	1998	0.00	0.00	0.09	0.00	0.09
	1999	0.00	0.00	0.00	0.00	0.00
SEBASTES MALIGER	1997	0.00	0.19	2.20	0.27	2.66
	1998	0.00	0.00	0.13	0.00	0.13
	1999	0.00	0.00	0.00	0.00	0.00
SEBASTES RUBERRIMUS	1997	0.00	0.00	0.10	0.00	0.10
	1998	0.00	0.00	0.00	0.00	0.00
	1999	0.00	0.00	0.00	0.00	0.00

* excludes PFMA 111
** includes PFMA 111

Table 5. Estimated landings of rockfish (numbers of fish) from the West Coast Vancouver Island Creel Survey (1999-2000).

		Statistical Area						
Year	Month	20	21	23	24	25	26	121
1999	May	209	0	0	0	0	0	0
	June	500	0	1925	876	280	35	0
	July	892	0	4821	2477	1513	277	0
	Aug	1080	0	6293	1990	1535	231	0
	Sept	846	0	1400	557	0	0	0
2000	June	844	0	228	557	70	0	0
	July	1183	0	2189	542	1928	0	138
	Aug	678	1033	1536	491	1507	0	0
	Sept	123	115	251	0	0	0	0

Source: DFO Catch stats web site http://www-sci.pac.dfo-mpo.gc.ca/sa/Recreational/recpage.htm

Table 6a. Estimated landings of rockfish (numbers of fish) and effort (boat trips) from the North Island Creel Survey.

Month	1999 Statistical Area 12			2000 Statistical Area 12		
	Rockfish	Effort	CPUE	Rockfish	Effort	CPUE
June	n/a	n/a	n/a	70	2148	0.03
July	6034	12088	0.5	4079	7075	0.58
Aug	9658	20355	0.47	4880	8859	0.55
Sept	3663	6708	0.55	n/a	n/a	n/a

Source: DFO Catch stats web site http://www-sci.pac.dfo-mpo.gc.ca/sa/Recreational/recpage.htm

Table 6b. Estimated landings by species of rockfish (numbers of fish) and effort (boat trips) from the North Island Creel Survey.

		Statisical Area 12						
Year	Survey Period	Black	China	Copper	Quillback	Tiger	Yelloweye	Effort
1999	July-Aug	1757.0	39.0	1129.0	6383.0	68.0	2959.0	32443
2000	July-Aug	74.2	26.4	669.0	3687.9	40.3	1729.5	15934

Source: DFO Catch stats web site http://www-sci.pac.dfo-mpo.gc.ca/sa/Recreational/recpage.htm

Table 7. Preliminary estimated landings (numbers of fish), effort (days fished) of rockfish and salmon from the 1999 North Coast Sportfish Report.

AREA	EFFORT	Salmon	Rockfish
1. QCI	n/a	25580	6705
2W. QCI	n/a	7360	787
2E. QCI	n/a	1230	
3. NASS	5457	3463	9800
4. SKEENA	4388	594	
6K . KITIMAT	12018	3415	1325
7. BELLA BELLA	4963	4561	1024
8. BELLA COOLA	24243	8695	1541
9. RIVERS INLET	35907	7563	2188

Source: DFO Catch stats web site http://www-sci.pac.dfo-mpo.gc.ca/sa/Recreational/recpage.htm

Table 8. Estimated landings (numbers of fish) coastwide from all recreational data sources.

Year	SG[1]	CC[2]	NC[3]	QCI[4]	WCVI[5]
1982	264459				
1983	185381				
1984	158678				
1985	134115				
1986	167786				
1987	136270				
1988	194784				
1989	199898				
1990	225066				
1991	251829				
1992	159920				
1993	138679				
1994	265305				
1995	168449				
1996	204544				
1997	149919				
1998	144427				
1999	215084	18234	29400	22476	58104
2000	133482				31755

[1] no data for area 12 and 20 for survey periods 1982-1998
[2] no data for areas 10, 106-110
[3] no data for areas 5,103-105
[4] no data for areas 101-102,130,142
[5] no data for area 11,27,111,122-127

Table 9. Aboriginal catch (kg) with by PFMA and month for the year 2000, from British Columbia Catch Statistics Unit.

	Month							
Stat Area	1	2	3	4	6	7	8	10
12	0.0	8.4	0.0	0.0	0.0	0.0	0.0	0
13	2.8	44.1	0.0	0.0	0.0	0.0	0.0	0
23	0.0	0.0	0.0	0.0	317.5	0.0	0.0	0
24	0.0	0.0	290.3	35.0	0.0	4.9	0.0	4.2
121	0.0	0.0	0.0	136.1	0.0	0.0	4.2	0
124	0.0	0.0	0.0	0.0	0.0	0.0	0.0	168.0
125	4.9	0.7	0.0	0.0	0.7	0.0	0.0	0

* all catch recorded in numbers of fish and converted to kg using an average weigh of 0.7 kg

Table 10a. Summary of total catch (kg) and its disposition by species from onboard observer trips in the Halibut longline, ZN longline and handline fisheries.

Common Name	Halibut by longline gear				ZN by longline gear				ZN by handline gear			
Observed Catch	unknown	retained	bait	discarded	unknown	retained	bait	discarded	unknown	retained	bait	discarded
Albatrosses	-	-	-	4.53	-	-	-	-	-	-	-	-
Arrowtooth flounder	1157.97	517.53	0.9	8535.85	-	-	-	233.09	-	-	-	-
Big skate	-	40.36	-	9483.86	-	-	-	127.41	-	-	-	11.33
Bigeye thresher	-	-	-	45.35	-	-	-	-	-	-	-	-
Bivalves	-	-	-	0.45	-	-	-	-	-	-	-	-
Black rockfish	-	5.43	-	4.08	-	7.24	-	-	-	7.69	-	52.58
Black-footed albatross	-	-	-	6.35	-	-	-	-	-	-	-	-
Blue shark	15.87	31.75	-	599.55	-	-	-	-	-	-	-	-
Bocaccio	-	240.35	-	117	-	5.86	-	-	-	14.51	-	-
Box crabs	-	-	-	0.45	-	-	-	-	-	-	-	-
Brittle stars	-	-	-	5.42	-	-	-	0.45	-	-	-	-
Brown irish lord	-	0.9	-	0.9	-	-	-	-	-	-	-	-
Butter sole	-	-	-	-	-	0.45	-	-	-	-	-	-
Cabezon	-	-	-	26.76	-	-	-	25.84	-	2.26	-	4.53
Canary rockfish	3.62	281.55	2.72	51.19	-	88.34	-	-	-	100.14	-	0.45
Cat sharks	-	-	-	103.84	-	-	-	-	-	-	-	-
Chilipepper	-	4.98	-	-	-	-	-	-	-	-	-	-
China rockfish	-	21.29	-	5.88	-	72.91	-	2.26	-	55.7	-	8.59
Cnidarians	-	-	-	-	-	-	-	0.45	-	-	-	-
Copper rockfish	-	20.39	-	11.32	-	54.78	-	-	-	63	-	0.45
Darkblotched rockfish	-	10.42	-	-	-	-	-	-	-	-	-	-
Dover sole	2.72	6.32	-	8.13	-	-	-	8.15	-	-	-	-
Dusky rockfish	-	2.72	-	4.53	-	-	-	-	-	-	-	-
Eelpouts	-	-	-	-	-	-	-	0.45	-	-	-	-
English sole	-	-	-	0.9	-	-	-	0.45	-	-	-	-
Flathead sole	-	-	-	-	-	0.45	-	-	-	-	-	-
Gastropods	-	-	-	4.5	-	-	-	-	-	-	-	-
Giant wrymouth	-	-	-	-	-	-	-	1.36	-	-	-	-
Gorgonian corals	-	-	-	3.17	-	-	-	-	-	-	-	-
Greenlings	-	-	-	6.8	0.45	21.66	-	1.8	-	10.41	-	1.35

Common Name	Halibut by longline gear				ZN by longline gear				ZN by handline gear			
Observed Catch	unknown	retained	bait	discarded	unknown	retained	bait	discarded	unknown	retained	bait	discarded
Greenstriped rockfish	3.17	99.22	-	9.5	-	3.15	-	-	-	0.45	-	0.45
Herrings	-	49.44	-	-	-	-	-	-	-	-	-	-
Inanimate objects	-	14.05	0.45	184.13	-	-	-	69.38	-	-	-	-
Kelp greenling	-	-	-	-	0.45	-	-	-	0.45	2.26	-	5.87
King crabs	-	-	2.26	-	-	-	-	-	-	-	-	-
Lefteye flounders	-	-	-	0.45	-	-	-	-	-	-	-	-
Lingcod	-	3224.56	5.89	2965.05	-	160.07	-	218.97	-	2166.24	5.44	129.59
Longnose skate	-	205.42	4.53	9350.78	-	-	-	311.05	-	-	-	-
Longspine thornyhead	5.44	-	-	-	-	-	-	-	-	-	-	-
Octopus	70.74	16.78	-	43.53	-	-	-	11.33	-	-	-	-
Oregontriton	-	-	-	0.45	-	-	-	-	-	-	-	-
Pacific cod	154.13	95.63	8.14	352.77	10.41	55.28	1.36	31.7	-	-	-	-
Pacific halibut	6.35	251870.68	28.11	32023.4	-	-	-	1533.89	-	-	-	121.08
Pacific ocean perch	53.07	13.56	-	10.42	-	-	-	-	-	-	-	-
Pacific sanddab	-	-	-	-	-	9.47	-	-	-	-	-	-
Pacific sleeper shark	-	-	-	1497.76	-	-	-	-	-	-	-	-
Petrale sole	-	4.54	12.69	26.71	-	4.07	-	-	-	-	-	-
Prowfish	-	-	-	-	-	-	-	5.44	-	-	-	-
Quillback rockfish	39.46	781.98	-	219.34	-	1027.01	-	160.96	-	250.59	-	31.67
Ragfish	-	-	-	17.22	-	-	-	-	-	-	-	-
Red irish lord	-	-	-	-	-	-	-	14.5	-	-	-	0.45
Redbanded rockfish	131.54	3484.6	14.96	2079.08	-	223.57	-	-	-	-	-	-
Redstripe rockfish	-	2.72	-	-	-	0.9	-	-	-	0.45	-	-
Requiem sharks	-	28.12	-	-	-	-	-	-	-	-	-	-
Rock sole	-	-	-	3.61	-	22.6	-	1.35	-	3.61	-	2.71
Rosethorn rockfish	4.5	50.23	-	43.89	-	5.86	-	-	-	-	-	-
Rougheye rockfish	41.27	3759.23	-	2731.5	-	10.85	-	-	-	-	-	-
Sablefish	556.97	22433.79	-	13425.7	-	6.8	-	810.03	-	-	-	-
Sand sole	-	-	-	-	-	0.9	-	-	-	-	-	0.45
Sandpaper skate	-	14.51	-	85.67	-	-	-	0.9	-	-	-	-
Sculpins	-	-	-	9.04	-	-	-	9.93	-	-	-	-
Sea anemones	-	-	-	3.15	-	-	-	0.9	-	-	-	-
Sea cucumbers	-	-	-	4.98	-	-	-	-	-	-	-	1.9

Common Name	Halibut by longline gear				ZN by longline gear				ZN by handline gear			
Observed Catch	unknown	retained	bait	discarded	unknown	retained	bait	discarded	unknown	retained	bait	discarded
Sea lilies/featherstars	-	-	-	0.45	-	-	-	-	-	-	-	-
Sea pens	-	-	-	0.45	-	-	-	-	-	-	-	-
Sea stars	-	0.9	-	2112.39	-	-	-	83.28	-	-	-	-
Sea urchins	-	-	-	6.75	-	-	-	-	-	-	-	-
Sharpchin rockfish	-	0.45	-	0.45	-	-	-	-	-	-	-	-
Shortraker rockfish	8.16	332.88	-	288.46	-	-	-	-	-	-	-	-
Shortspine thornyhead	71.66	768.52	-	337.36	-	16.31	-	39.46	-	-	-	-
Silvergray rockfish	18.13	1015.68	-	378.21	-	96.01	0.45	-	-	9.5	-	-
Sixgill shark	-	-	-	408.21	-	-	-	-	-	-	-	-
Skates	-	-	-	125.61	-	-	-	-	-	-	-	-
Soft corals	-	-	-	1.35	-	-	-	-	-	-	-	-
Spiny dogfish	1374.8	2599.39	-	26119.82	-	-	-	1131.02	-	-	-	-
Splitnose rockfish	-	-	-	1.35	-	-	-	-	-	-	-	-
Sponges	-	-	-	2.26	-	-	-	-	-	-	-	-
Spotted ratfish	1.36	-	-	1112.51	38.95	-	-	411.15	-	-	-	0.45
Starry skate	-	-	-	256.26	-	-	-	-	-	-	-	-
Tanner crabs	-	-	-	1.81	-	-	-	-	-	-	-	-
Tiger rockfish	-	39.39	-	7.68	-	80.13	-	-	-	7.68	-	4.98
Vermilion rockfish	-	1.81	-	7.25	-	0.9	-	-	-	-	-	-
Walleye pollock	-	-	-	1.36	-	-	-	-	-	-	-	-
Widow rockfish	-	3.62	-	-	-	-	-	-	-	2.72	-	-
Wolf eel	-	-	-	40.76	-	-	-	5.44	-	-	-	-
Yelloweye rockfish	3.17	6483.34	22.66	2342.21	-	2447.64	-	-	-	777.35	-	123.77
Yellowfin sole	-	-	-	-	-	3.16	-	-	-	-	-	-
Yellowmouth rockfish	-	263.01	-	136.02	-	-	-	-	-	-	-	-
Yellowtail rockfish	-	14.49	-	9.06	-	26.69	-	-	-	48.94	-	0.45
TOTAL WEIGHTS	*3724.1*	*298856.51*	*103.31*	*117816.98*	*50.26*	*4453.06*	*1.81*	*5252.39*	*0.45*	*3523.5*	*5.44*	*503.1*

Table 10b. Summary of the inshore rockfish catch (kg) and its disposition by species and for all rockfish species from onboard observer trips for the Halibut longline, ZN longline and handline fisheries.

Common Name	Halibut by longline gear				ZN by longline gear				ZN by handline gear			
Observed Catch	unknown	retained	bait	discarded	unknown	retained	bait	discarded	unknown	retained	bait	discarded
Copper rockfish	-	20.39	-	11.32	-	54.78	-	-	-	63	-	0.45
Quillback rockfish	39.46	781.98	-	219.34	-	1027.01	-	160.96	-	250.59	-	31.67
Black rockfish	-	5.43	-	4.08	-	7.24	-	-	-	7.69	-	52.58
China rockfish	-	21.29	-	5.88	-	72.91	-	2.26	-	55.7	-	8.59
Tiger rockfish	-	39.39	-	7.68	-	80.13	-	-	-	7.68	-	4.98
Yelloweye rockfish	3.17	6483.34	22.66	2342.21	-	2447.64	-	-	-	777.35	-	123.77
All rockfish species	306.13	16933.45	40.36	8466.64	-	4151.84	0.45	164.57	-	1338.72	-	223.39

Table 10c. Weight percentage of inshore rockfish catch landed by species and for all rockfish species from onboard observer trips for Halibut longline, ZN longline and handline fisheries.

Common Name	Halibut longline gear	ZN by longline gear	ZN by handline gear	ZN
Observed Catch	Percent of catch landed	Percent of catch landed	Percent of catch landed	Percent of catch landed
Copper rockfish	64.3	100	99.3	99.6
Quillback rockfish	78.1	86.5	88.7	86.9
Black rockfish	57.1	100	12.8	22.1
China rockfish	78.4	76.6	86.6	92.2
Tiger rockfish	83.7	100	60.7	94.6
Yelloweye rockfish	73.3	100	86.3	96.3
All rockfish species	78.0	96.2	85.7	93.4

Table 11. Reported landings (t) of commercial hook and line rockfish (all species combined) for the Strait of Georgia by statistical area and for all areas combined catch, from British Columbia Catch Statistics, Annual Reports, 1954-1995. Combined data for 1996-2000 from PacHarvHL and PacHarv3.

	Statistical Areas											
Year	12	13	14	15	16	17	18	19	20	28	29	Total
1954	9.3	6.8	0.8	0.5	7.0	15.1	6.7	0.7	0.0	0.4	0.0	47.3
1955	12.3	3.5	0.5	1.8	7.0	16.1	4.2	0.1	0.1	0.0	0.0	45.6
1956	24.7	1.9	0.1	1.0	5.0	19.5	5.4	0.1	0.1	0.0	0.2	58.0
1957	20.7	6.1	2.4	2.6	14.8	25.8	6.9	6.4	0.0	0.1	1.1	86.9
1958	10.7	10.7	9.7	6.1	15.7	29.2	15.8	6.2	3.2	0.0	1.9	109.2
1959	9.3	16.2	9.5	11.2	10.9	38.8	4.0	3.9	0.5	0.1	0.6	105.0
1960	6.7	20.2	4.4	12.2	11.6	20.8	3.5	3.2	0.9	0.3	0.1	83.9
1961	13.8	17.0	6.4	2.8	4.8	17.3	3.4	1.4	0.7	0.2	1.4	69.2
1962	55.6	15.4	4.6	5.8	3.1	19.8	2.4	2.5	0.5	0.2	0.5	110.4
1963	44.6	7.7	3.6	1.6	6.3	16.3	2.8	0.9	0.2	0.0	0.2	84.2
1964	14.2	4.5	2.1	0.8	15.1	8.8	2.8	1.1	0.5	0.1	0.1	50.1
1965	14.0	3.5	2.1	0.1	10.4	9.2	3.2	0.4	0.1	0.0	0.3	43.3
1966	5.6	3.7	3.7	0.5	14.4	4.7	4.1	0.2	0.1	0.0	0.0	37.0
1967	13.5	7.6	5.8	3.4	18.1	6.2	0.8	0.1	0.1	0.0	0.0	55.6
1968	15.6	8.2	0.4	1.0	19.6	10.3	1.3	0.1	0.1	0.0	0.0	56.6
1969	29.0	12.0	3.9	3.6	17.2	8.8	4.1	2.7	0.9	0.0	0.0	82.2
1970	31.3	17.5	4.0	5.0	9.9	16.3	1.6	0.6	1.0	0.0	0.0	87.2
1971	37.0	9.4	2.7	5.1	6.9	12.1	1.0	0.2	0.1	0.0	0.0	74.5
1972	45.4	13.8	4.3	4.7	11.7	12.2	1.2	0.8	0.1	0.0	0.2	94.4
1973	44.4	13.0	2.7	8.6	19.6	11.1	1.4	0.0	0.0	0.0	0.0	100.8
1974	9.7	7.3	3.2	3.2	3.0	8.1	3.0	0.0	0.0	0.0	0.0	37.5
1975	7.3	6.0	2.3	7.2	2.0	10.0	4.5	0.5	0.0	0.0	0.5	40.3
1976	10.9	10.4	5.0	7.7	2.7	7.3	2.7	0.0	0.9	0.0	0.5	48.1
1977	55.8	17.7	9.1	15.9	5.4	10.9	15.0	2.7	0.5	3.5	1.5	138.0
1978	21.0	30.0	7.0	15.0	17.0	26.0	29.0	5.0	1.0	1.0	4.0	156.0
1979	40.0	63.0	12.0	16.0	27.0	37.0	46.0	5.0	1.0	3.0	5.0	250.0
1980	27.0	43.0	10.0	12.0	20.0	20.0	35.0	5.0	2.0	3.0	3.0	180.0
1981	20.8	55.7	12.8	27.9	28.3	20.2	38.3	3.3	0.8	1.1	2.4	211.6
1982	21.3	106.7	9.0	75.6	33.7	10.6	18.2	2.3	0.2	0.5	3.0	281.1
1983	11.6	199.8	9.4	11.3	30.4	15.1	16.1	1.8	0.3	2.0	0.9	298.7
1984	32.8	198.1	3.5	13.3	24.7	39.8	23.7	8.0	2.1	0.4	0.9	347.3
1985	106.3	153.1	5.0	17.7	22.9	84.9	34.7	9.1	1.4	0.1	1.6	436.8
1986	136.3	142.6	18.4	24.9	58.7	63.1	45.8	23.6	9.3	0.2	2.5	525.4
1987	113.2	119.9	10.0	18.8	17.8	32.9	30.4	35.0	12.6	12.4	10.7	413.7
1988	185.6	90.3	13.6	25.6	31.4	61.0	29.5	28.0	20.1	0.0	11.6	496.7
1989	230.1	68.1	20.4	12.8	12.5	57.0	19.0	34.5	5.0	0.1	0.7	460.2
1990	254.7	81.6	18.3	12.3	12.3	51.8	15.2	15.7	2.8	1.5	3.4	469.6
1991	178.5	192.6	5.0	8.5	6.6	45.9	26.0	15.6	0.5	0.2	1.6	481.0
1992	60.2	56.1	5.4	1.0	3.1	22.7	21.8	4.9	1.6	0.0	0.0	176.8
1993	80.3	52.2	4.9	0.5	0.8	21.6	20.0	16.1	1.7	0.0	0.8	198.9
1994	136.1	70.5	11.0	0.4	0.7	26.5	11.4	12.8	4.9	0.1	1.7	276.1
1995	82.2	64.3	3.8	0.2	0.4	23.3	6.8	7.8	5.3	0.0	3.7	197.8
1996*	96.4	53.9	1.4	0.9	0.3	14.9	7.0	4.9	1.6	0.0	0.3	186.8
1997*	91.5	49.6	5.3	0.6	0.0	11.3	7.1	6.6	0.0	0.0	1.0	174.6
1998*	123.9	28.5	0.3	0.3	0.0	5.1	3.8	5.3	0.3	0.0	0.7	170.2
1999*	116.9	21.6	0.2	0.0	0.0	4.0	2.3	3.6	0.0	0.0	0.0	150.0
2000*	98.4	24.1	3.1	0.0	0.2	4.2	4.5	2.4	1.7	0.0	2.2	141.2

* no pfma statistical area information provided for Schedule II Fishery, only Yelloweye, Aggregate 1&2 included in Strait of Georgia total. No accurate pfma statistical area information provided in Halibut dataset for Strait of Georgia.

Table 12a. Estimated rockfish catch in numbers (pieces) by statistical area from the Strait of Georgia Creel Survey.

Year	Survey Period	Statistical Area								
		13	14	15	16	17	18	19	28	29
1982	May-Dec	19602	17101	3645	53993	17071	22509	25001	10466	6918
1983	Jan-Dec	36589	17030	3749	36877	18051	20458	32255	12747	7625
1984	Jan-Dec	22731	14449	4290	16117	35331	20276	26720	10761	8003
1985	Jan-Dec	14416	12397	1712	38544	20857	12123	20305	7201	6560
1986	Jan-Dec	21245	20680	2702	48914	18449	12926	28631	6993	7246
1987	Jan-Dec	16362	22697	2969	20594	22988	14886	27906	4222	3646
1988	Jan-Dec	24719	30035	2784	38234	30460	17125	34932	5953	10542
1989	Jan-Dec	18777	31837	3110	48461	33649	19903	29176	5936	9049
1990	March-Oct	18440	22886	2476	42562	15633	7099	27004	6257	7687
1991	March-Oct	16919	23486	2176	47617	20327	6599	16394	10926	23442
1992	March-Dec	14594	13926	1263	43571	17763	9104	19083	7203	6760
1993	Jan-Sept	15804	9289	1251	20944	15002	5397	21054	5499	9769
1994	Apr-Oct	28130	24860	2833	29320	19672	5341	19699	12108	12798
1995	March-Oct	19402	12728	2223	29380	15179	5648	14118	5324	8297
1996	Apr-Sept	23348	5300	1885	32991	6765	3083	16958	6818	5124
1997	Apr-Oct	19914	6189	2268	21475	10033	4923	10333	7045	5273
1998	Apr-Oct	30107	3668	2199	17782	9125	3344	14514	2281	1229
1999	Apr-Sept	21742	2474	574	17653	5439	1284	9449	4995	990
2000	Apr-Oct	10963	2211	523	19950	6236	1327	6333	2964	1341

Source: DFO Catch Statistics Web Reports http://www-sci.pac.dfo-mpo.gc.ca/sa/Recreational/recpage.htm.

Table 12b. Estimated rockfish fishing effort in boat trips by statistical area from the Strait of Georgia Creel Survey.

Year	Survey Period	Statistical Area								
		13	14	15	16	17	18	19	28	29
1982	May-Dec	101370	119633	10355	55072	58344	49276	93941	46391	25011
1983	Jan-Dec	118095	99391	9511	50288	58404	41114	103686	36626	16613
1984	Jan-Dec	142774	105410	10549	81349	86446	42405	104441	39963	37751
1985	Jan-Dec	132934	118224	12095	87292	69868	32448	115069	34414	26172
1986	Jan-Dec	132178	117359	14123	70539	65610	28000	96969	31701	26492
1987	Jan-Dec	121369	122735	12104	57794	73109	30377	122159	23349	26635
1988	Jan-Dec	136924	158629	11196	62719	82905	35024	124946	18819	33208
1989	Jan-Dec	128697	133622	9427	48904	74793	32877	126064	19418	29269
1990	March-Oct	119310	128932	7971	41654	66810	20058	96445	14663	28915
1991	March-Oct	91084	96609	8297	38670	49312	18611	106970	13919	27957
1992	March-Dec	84804	122943	7349	58403	57575	17699	81407	14765	13520
1993	Jan-Sept	96948	124920	8982	58897	74275	15824	84650	9836	23694
1994	Apr-Oct	93333	109147	11753	39654	52693	12317	86392	13295	22160
1995	March-Oct	59711	70611	7056	32199	35062	15331	82508	9207	13957
1996	Apr-Sept	54571	49690	8794	36709	33444	11087	73855	9071	11515
1997	Apr-Oct	41317	48926	6686	28363	23653	12744	83664	11596	11848
1998	Apr-Oct	25727	27513	4362	16974	15524	9876	46253	10678	5386
1999	Apr-Sept	31558.8	22547	2530	16297.1	20813	8819.1	39414	10595	4813
2000	Apr-Oct	39214	24277	3231	15368	15572	8742	38723	10057	6708

Source: DFO Catch Statistics Web Reports http://www-sci.pac.dfo-mpo.gc.ca/sa/Recreational/recpage.htm

Table 13. Estimated recreational catch in numbers (pieces) of salmon and rockfish from the Strait of Georgia Creel Survey (1982-2000).

	Catch		Effort
YEAR	Salmon	Rockfish	Trips
1982	547212	176306	559393
1983	628876	185381	533728
1984	828291	158678	651088
1985	1062941	134115	628516
1986	760362	167786	582971
1987	864660	136270	589631
1988	1227632	194784	664370
1989	775616	199898	603071
1990	773784	150044	524758
1991	521355	167886	451429
1992	736997	133267	458465
1993	1184150	104009	498026
1994	401611	154761	440744
1995	347401	112299	323642
1996	233176	102272	288736
1997	293605	87453	268797
1998	38448	84249	162293
1999	71038	64600	157387
2000	52148	51848	161892

Source: DFO Catch stats web site http://www-sci.pac.dfo-mpo.gc.ca/sa/Recreational/recpage.htm.

Table 14a. Estimated commercial (Com) and recreational (Rec) catch in tonnes for the Strait of Georgia by PFMA.

	12		13		14		15		16		17		18		19		20		28		29	
Year	Com	Rec*	Com	Rec	Com	Rec	Com	Rec	Com	Rec	Com	Rec	Com	Rec	Com	Rec	Com	Rec*	Com	Rec	Com	Rec
1982	21.3	92.6	106.7	20.6	9.0	18.0	75.6	3.8	33.7	56.7	10.6	17.9	18.2	23.6	2.3	26.3	0.2	15.0	0.5	11.0	3.0	7.3
1983	11.6	64.9	199.8	25.6	9.4	11.9	11.3	2.6	30.4	25.8	15.1	12.6	16.1	14.3	1.8	22.6	0.3	10.5	2.0	8.9	0.9	5.3
1984	32.8	55.5	198.1	15.9	3.5	10.1	13.3	3.0	24.7	11.3	39.8	24.7	23.7	14.2	8.0	18.7	2.1	9.0	0.4	7.5	0.9	5.6
1985	106.3	46.9	153.1	10.1	5.0	8.7	17.7	1.2	22.9	27.0	84.9	14.6	34.7	8.5	9.1	14.2	1.4	7.6	0.1	5.0	1.6	4.6
1986	136.3	58.7	142.6	14.9	18.4	14.5	24.9	1.9	58.7	34.2	63.1	12.9	45.8	9.0	23.6	20.0	9.3	9.5	0.2	4.9	2.5	5.1
1987	113.2	47.7	119.9	11.5	10.0	15.9	18.8	2.1	17.8	14.4	32.9	16.1	30.4	10.4	35.0	19.5	12.6	7.7	12.4	3.0	10.7	2.6
1988	185.6	68.2	90.3	17.3	13.6	21.0	25.6	1.9	31.4	26.8	61.0	21.3	29.5	12.0	28.0	24.5	20.1	11.0	0.0	4.2	11.6	7.4
1989	230.1	70.0	68.1	13.1	20.4	22.3	12.8	2.2	12.5	33.9	57.0	23.6	19.0	13.9	34.5	20.4	5.0	11.3	0.1	4.2	0.7	6.3
1990	254.7	78.8	81.6	19.4	18.3	24.0	12.3	2.6	12.3	44.7	51.8	16.4	15.2	7.5	15.7	28.4	2.8	12.8	1.5	6.6	3.4	8.1
1991	178.5	88.1	192.6	17.8	5.0	24.7	8.5	2.3	6.6	50.0	45.9	21.3	26.0	6.9	15.6	17.2	0.5	14.3	0.2	11.5	1.6	24.6
1992	60.2	56.0	56.1	12.3	5.4	11.7	1.0	1.1	3.1	36.6	22.7	14.9	21.8	7.6	4.9	16.0	1.6	9.1	0.0	6.1	0.0	5.7
1993	80.3	48.5	52.2	14.8	4.9	8.7	0.5	1.2	0.8	19.5	21.6	14.0	20.0	5.0	16.1	19.7	1.7	7.9	0.0	5.1	0.8	9.1
1994	136.1	92.9	70.5	33.8	11.0	29.8	0.4	3.4	0.7	35.2	26.5	23.6	11.4	6.4	12.8	23.6	4.9	15.0	0.1	14.5	1.7	15.4
1995	82.2	59.0	64.3	20.4	3.8	13.4	0.2	2.3	0.4	30.8	23.3	15.9	6.8	5.9	7.8	14.8	5.3	9.5	0.0	5.6	3.7	8.7
1996	96.4	71.6	53.9	32.7	1.4	7.4	0.9	2.6	0.3	46.2	14.9	9.5	7.0	4.3	4.9	23.7	1.6	11.6	0.0	9.5	0.3	7.2
1997	91.5	52.5	49.6	23.9	5.3	7.4	0.6	2.7	0.0	25.8	11.3	12.0	7.1	5.9	6.6	12.4	0.0	8.5	0.0	8.5	1.0	6.3
1998	123.9	50.5	28.5	36.1	0.3	4.4	0.3	2.6	0.0	21.3	5.1	11.0	3.8	4.0	5.3	17.4	0.3	8.2	0.0	2.7	0.7	1.5
1999	116.9	54.2	21.6	30.4	0.2	3.5	0.0	0.8	0.0	24.7	4.0	7.6	2.3	1.8	3.6	13.2	0.0	5.9	0.0	7.0	0.0	1.4
2000	98.4	25.3	24.1	13.2	3.1	2.7	0.0	0.6	0.2	23.9	4.2	7.5	4.5	1.6	2.4	7.6	1.7	5.9	0.0	3.6	2.2	1.6

Table 14b. Estimated commercial (Com) and recreational (Rec) rockfish catch in tonnes for grouped years.

	12		13		14		15		16		17		18		19		20		28		29	
Year	Com	Rec*	Com	Rec	Com	Rec	Com	Rec	Com	Rec	Com	Rec	Com	Rec	Com	Rec	Com	Rec*	Com	Rec	Com	Rec
82-85	172.0	259.9	657.7	72.2	26.9	48.7	117.9	10.7	111.7	120.8	150.4	69.9	92.7	60.6	21.2	81.7	4.0	42.1	3.0	32.5	6.4	22.8
86-90	919.9	323.3	502.5	76.1	80.7	97.7	94.4	10.7	132.7	154.0	265.8	90.3	139.9	52.8	136.8	112.8	49.8	52.3	14.2	22.7	28.9	29.4
91-95	537.3	344.5	435.7	98.9	30.1	88.2	10.6	10.2	11.6	172.2	140.0	89.8	86.0	32.0	57.2	91.4	14.0	55.8	0.3	42.8	7.8	63.5
96-00	527.1	254.1	177.7	136.3	10.3	25.4	1.8	9.4	0.5	141.9	39.5	47.6	24.7	17.6	22.8	74.4	3.6	40.1	0.0	31.3	4.2	18.0

* data estimated for 1982-1998 based on 1999-2000

Table 15. History of management actions by year and area.

Year	Area	Management Action
<1986	coast-wide	unrestricted fishery
1986	coast-wide	introduced Zn licence with a logbook requirement
	SG	Feb 15 - Apr 15 closure
1987	SG	Jan 1 - Apr 15 closure
	SG - area 12	75 t quota
1987-1990	SG	incidental yelloweye rockfish catch permitted during the winter closure
1988	SG - area 13 - Discovery Pass	year round commercial closure
	SG	Jan 1 - Apr 30 closure
1990	SG	Jan 1 - Apr 30 and Nov 1 - Dec 31 closure
	outside	650 t quota
	CC - area 7	portions closed
1990-1991	WCVI inside the surfline	Jan 1 - Apr 30 closed
1991	inside/outside	area licensing, 592 inside (SG) and 1,591 outside (all remaining regions)
	SG	trawl closure
	SG	live rockfish fishery only
	SG	Jan 1 - May 14 closure with no incidental rockfish catch allowances
	SG - area 13	2-3 day opening in Discovery Pass
	CC - area 7	rotational closure was initiated
	coast-wide	limited entry licensing program was announced
1992	SG	limited entry licensing with 74 eligible inside licences
1993	outside	limited entry licensing with 183 eligible outside licences
	coast-wide	quota management (red snapper and other rockfish) by region
	coast-wide	region/time closures
1994	coast-wide	user pay logbook program
	coast-wide	trip limits for trawl species
	coast-wide	incidental catch allowances
1995	coast-wide	user pay dockside monitoring program
	coast-wide	aggregate species quota management (yelloweye rockfish and agg. 1&2)
	coast-wide	monthly fishing periods, fishing period limits, annual landing options and trip limits
	coast-wide	relinquishment of period limit overages
1996	coast-wide	change species aggregates
1997	coast-wide	initiate 5% quota allocation for research purposes
1998/99	coast-wide	92% of commercial rockfish TAC allocated to the trawl sector, 8% to hook & line sector
	SG	100% of commercial rockfish TAC allocated to the hook & line sector
1999/00	coast-wide	10% at sea observer coverage
	coast-wide	quillback, copper, china, tiger TAC reduced by 25%
	selected areas	rockfish protection area closures
2000/2001	coast-wide	allocation of rockfish species between the halibut and hook & line sectors

Table 16. Red snapper (yelloweye rockfish) and other rockfish catch quotas in tonnes for the five management regions between 1991 and 2000.

Region		Yelloweye	Aggregate 1&2 or Other Rockfish*	Coastwide	Aggregate 3	Aggregate 4	Aggregate 5
QCI	1991	200	100		n/a	n/a	n/a
	1992	200	100		n/a	n/a	n/a
	1993	200	100		n/a	n/a	n/a
	1994	200	54		n/a	n/a	n/a
	1995	189	50		8925	735	8522
	1996	135	43		7800	1794	6585
	1997	123	40		9102	2648	10563
	1998	117	38		148	556	36
	1999	91	21		144	709	36
	2000	91	21		467.9	600.6	28.1
NC	1991	80	20				
	1992	80	20				
	1993	80	60				
	1994	60	60				
	1995	47	60				
	1996	38	62				
	1997	36	59				
	1998	32	51				
	1999	27	36				
	2000	27	36				
CC	1991	100	100				
	1992	100	100				
	1993	100	100				
	1994	100	100				
	1995	100	100				
	1996	119	116				
	1997	112	110				
	1998	99	100				
	1999	86	70				
	2000	86	70				
SG	1991	50	300				
	1992	59	130				
	1993	70	140				
	1994	70	150				
	1995	62	150				
	1996	26	150				
	1997	24	143				
	1998	23	130				
	1999	20	102				
	2000	20	102				
WCVI	1991	250	150				
	1992	250	150				
	1993	250	150				
	1994	200	150				
	1995	195	135				
	1996	155	152				
	1997	146	144				
	1998	133	133				
	1999	111	96				
	2000	111	96				

*1991-1994 quota classified as 'Other Rockfish', 1995-2000 quota classified by Aggregates.

Table 17. Recreational catch per effort between June and August in numbers of fish (pieces) per 10 boat trips for the Strait of Georgia.

	Statistical Area								
Year	13	14	15	16	17	18	19	28	29
1982	2.08	1.35	3.13	8.71	3.58	4.33	2.24	2.26	3.10
1983	3.41	1.51	4.23	7.81	2.27	5.22	2.64	3.98	5.18
1984	1.46	1.51	3.33	1.57	4.03	4.58	2.16	2.93	2.59
1985	0.80	1.03	1.42	5.19	3.38	3.36	1.78	2.33	2.73
1986	1.46	2.11	2.11	8.14	3.08	4.47	2.63	2.66	3.55
1987	1.24	2.19	2.43	4.00	2.96	5.61	1.77	2.12	1.96
1988	1.79	2.13	2.39	5.94	4.41	5.19	2.79	3.85	4.03
1989	1.09	2.39	3.57	12.27	4.87	7.16	1.56	4.16	4.06
1990	1.29	1.69	3.13	9.97	2.69	3.06	2.65	6.29	3.16
1991	1.83	3.22	2.55	17.16	5.09	3.41	1.58	8.47	7.45
1992	1.54	1.41	2.26	9.27	4.56	5.12	1.93	5.43	6.51
1993	1.35	0.74	1.38	4.10	2.04	3.22	2.24	6.10	5.00
1994	2.20	1.67	1.69	6.81	3.11	5.86	2.54	8.46	5.34
1995	2.55	2.24	2.84	7.45	4.08	5.21	1.30	4.82	8.59
1996	3.58	1.29	2.02	9.63	2.19	3.08	1.89	8.75	5.28
1997	4.68	1.33	3.21	9.13	3.35	4.11	1.43	7.60	5.64
1998	10.49	1.61	4.18	10.70	6.39	5.36	2.33	2.24	2.09
1999	6.18	1.06	2.22	11.18	2.78	1.63	1.59	6.01	2.68
2000	2.08	0.99	1.88	15.13	4.07	2.71	1.29	3.60	3.15

Table 18. Summary statistics of catch rates (number of fish (pieces) per 500 hooks) for survey and logbook data.

	n	Min	1st quartile	Median	Mean	3rd quartile	Max	Std. Dev.
Survey								
Flamingo	32	4	17.50	40	39.97	56.50	99	24.63
Tasu	33	4	23.00	34	39.76	52.00	119	26.64
Top Knot	20	5	12.25	18	19.65	24.75	39	10.00
Triangle	35	3	17.50	38	45.66	67.00	137	36.26
Logbook								
Flamingo	79	0	20.12	29.80	33.53	42.36	155.0	24.12
Tasu	172	0	9.75	25.62	34.73	45.00	225.0	39.36
Top Knot	136	0	7.50	13.75	18.51	23.50	76.5	14.97
Triangle	302	0	10.00	19.19	25.51	35.30	131.2	23.06

Source: Kronlund and Yamanaka 2001

Table 19a. Copper rockfish (*Sebastes caurinus*) mean length (centimetres) and mean age (years) by sex, gear type, fishery type, Major and Minor area and year.

Copper rockfish (*Sebastes caurinus*)					Males			Females			Males			Females		
Gear	Fishery	Major	Minor	Year	Length	std	n	Length	std	N	Age	std	n	Age	std	n
BT trawl	commercial	08	05	1991	42.0	3.57	12	42.6	4.39	20			0			0
		08	05	1992	41.5	4.31	79	40.4	4.27	27			0			0
		08	05	1993	41.7	4.55	21	42.0	4.93	29			0			0
		08	05	1994	39.4	3.65	28	39.5	2.60	22			0			0
		08	05	1995	39.1	4.08	59	40.3	3.53	41			0			0
	research	07	02	1995	40.8	4.90	27						0			0
		07	02	2000	36.4	3.98	22	37.3	3.55	26						
	observed	07	02	1998	39.3	2.13	30						0			
		07	06	2000	37.6	3.10	50	36.2	3.21	16			0			0
		08	01	1999	40.4	4.01	34	39.9	3.86	23			0			0
		08	01	2000	39.1	4.72	43	39.5	4.55	31			0			0
		08	05	1999	37.4	4.06	40	37.3	4.39	13			0			0
gillnet	research	03	24	1991	19.4	6.65	19	21.6	5.64	25			0			0
handline	commercial	01	12	1986	27.2	4.26	96	27.5	4.40	71			0			0
		01	13	1984	31.4	4.86	77	33.0	5.43	78	9.8	4.14	58	12.4	6.35	49
		01	13	1985	31.6	3.60	52	31.3	3.82	48			0			0
		01	13	1987	31.2	4.97	27	29.9	4.63	24			0			0
		01	13	1992	32.0	3.73	40	32.2	4.86	53	6.3	1.84	21	7.6	3.7	29
		01	17	1986	31.5	2.96	23	33.8	4.16	54	9.7	2.08	3	13.8	4.64	17
		01	18	1992	40.4	6.28	25	39.1	5.83	26						
		01	19	1992				37.4	5.13	14						
		06	08	1989	33.3	6.58	11						0			
	research	01	13	1988	30.0	2.98	89	29.5	5.64	12	10.6	3.87	60	10.9	3.91	67
		03	24	1991	31.9	7.24	14	29.2	6.58	21			0			0
longline	commercial	00	00	1998				41.0	5.68	15						
		01	12	1998	33.0	2.89	11	35.6	7.03	12						
		07	02	1995	39.5	3.64	33	38.8	1.93	17						
		07	07	1993				37.6	3.73	11						
	observed	07	02	1993	38.6	5.98	63	37.9	7.19	54						
troll	commercial	01	17	1993	35.9	5.76	87	36.3	5.85	39	13.3	5.69	30	13.0	5.09	78
		01	18	1992	42.0	7.40	90	42.0	7.41	90	13.8	8.70	27	16.3	7.63	23

Table 19b. Black, china and tiger rockfish (*Sebastes melanops, S. nebulosus and S. nigrocinctus*) mean length (centimetres) and mean age (years) in the commercial fishery by sex, Major and Minor area and year.

Commercial fishery				Males			Females			Males			Females		
Species	Major	Minor	Year	Length	std	n	Length	std	N	Age	std	n	Age	std	N
S. melanops	01	12	1994	46.3	5.67	13						0			
S. nebulosus	07	07	1996	34.1	2.98	14	33.3	3.48	24			0			0
S. nebulosus	07	02	1993	31.6	1.87	17	31.2	2.37	20			0			0
S. nigrocinctus	03	23	1996	40.3	3.45	19						0			

Table 19c. Quillback rockfish (*Sebastes maliger*) mean length (centimetres) and mean age (years) by sex, gear type, fishery type, Major and Minor area and year.

Quillback rockfish (*Sebastes maliger*)					Males			Females			Males			Females		
Gear	Fishery	Major	Minor	Year	Length	std	n	Length	std	n	Age	std	n	Age	std	n
BT trawl	Commercial	01	14	1989	37.4	3.06	19	34.7	7.26	16			0			0
		05	11	1992	38.6	3.06	49	38.5	3.66	51			0			0
		05	11	1995	41.5	3.13	33	41.3	4.12	27			0			0
		08	01	1990	36.9	3.69	89	38.3	3.68	67			0			0
		08	03	1992	37.9	4.89	27	38.5	4.98	33			0			0
		08	04	1992	39.0	3.13	49	40.8	3.21	47			0			0
		08	05	1992	38.1	4.35	58	39.5	4.55	41			0			0
		08	05	1993	38.7	3.56	60	40.4	3.41	40			0			0
		08	05	1994	37.2	3.14	31	40.0	3.92	19			0			0
	Research	03	24	1991	37.2	6.05	29	38.9	5.02	34			0			0
		07	02	1996	30.2	5.02	31	28.4	5.22	23			0			0
		07	02	1998	34.9	4.69	43	34.4	5.66	37			0			0
		07	02	2000	34.3	4.49	32	35.7	3.07	17			0			0
		07	06	1993	34.1	4.62	22	34.2	4.93	18						
	Charter	03	24	1991				38.6	4.22	19						0
	Observed	05	11	1998	39.7	3.55	23	38.2	3.65	28			0			0
		05	11	2000	36.0	4.85	52	33.4	5.59	64			0			0
		06	08	1999	41.1	4.26	39	40.7	4.42	39			0			0
		07	02	1999	32.4	4.45	46	32.1	4.00	42			0			0
		07	06	1997	32.4	3.05	35	33.8	3.91	20			0			0
		08	05	1999	35.5	3.37	26						0			
handline	Commercial	01	12	1984	39.1	2.31	85	39.2	3.12	138	33.9	13.88	86	35.0	12.07	139
		01	12	1985	34.9	2.96	140	34.7	3.09	121	30.3	13.10	48	31.8	12.40	31

Quillback rockfish (*Sebastes maliger*)					Males			Females			Males			Females		
Gear	Fishery	Major	Minor	Year	Length	std	n	Length	std	n	Age	std	n	Age	std	n
		01	12	1986	34.6	6.09	218	37.4	6.28	260	22.7	10.58	63	27.3	10.54	137
		01	12	1987	35.2	5.46	370	35.7	6.15	392	23.4	10.04	144	24.3	11.60	157
		01	12	1988	35.7	5.49	211	36.5	5.44	224	23.3	10.86	91	23.5	10.80	112
		01	12	1989	34.7	4.55	102	35.7	4.41	121	22.0	10.07	100	23.5	11.53	121
		01	12	1990	34.9	4.73	146	34.8	5.38	151	20.9	13.54	73	21.7	12.43	89
		01	12	1991	34.9	3.86	30	34.8	3.09	20	21.9	9.77	30	19.3	7.32	20
		01	12	1992	34.1	4.17	78	34.9	4.24	53	20.7	11.49	78	20.1	9.23	53
		01	12	1993	37.1	5.41	232	36.2	6.14	270	19.3	7.56	24	22.6	10.45	30
		01	12	1994	36.0	4.15	53	34.3	5.58	98						
		01	12	1996	33.1	4.32	38	31.0	4.13	51	15.2	9.05	38	13.5	6.01	51
		01	12	2000	37.1	6.27	46	38.6	5.35	46	21.6	14.16	46	22.9	14.68	46
		01	12	2001	32.6	4.67	282	31.4	4.92	269	14.6	7.73	282	13.8	6.51	269
		01	13	1984	32.6	4.21	276	32.8	4.67	306	17.0	7.88	71	18.1	8.58	75
		01	13	1985	32.0	4.36	467	32.2	4.80	339	22.2	9.13	35	21.5	11.38	40
		01	13	1986	31.4	5.04	294	32.5	5.35	313	15.4	8.73	173	18.4	10.31	212
		01	13	1987	28.9	4.42	268	29.1	4.70	253	14.3	8.10	45	14.2	6.14	56
		01	13	1992	31.9	2.66	30	32.2	4.13	20	16.1	7.27	30	15.2	6.27	20
		01	13	1993	30.9	3.44	33	30.6	4.31	38	11.2	3.97	33	12.2	5.22	38
		01	13	1994	34.6	4.48	32	33.2	5.94	38	18.7	8.17	32	16.6	10.79	38
		01	13	1996	32.1	3.09	17	30.7	2.64	13			0			0
		01	17	1986	34.0	4.33	123	35.4	4.38	199	17.5	7.79	120	20.0	9.04	199
		01	17	1992	32.7	3.49	16	35.5	3.19	34	21.0	9.79	16	24.7	11.15	34
		01	17	2000	29.8	5.47	40	30.2	5.45	58	12.8	7.90	41	13.8	9.84	58
		01	18	1988	33.7	5.69	139	33.6	6.13	151	14.6	10.06	68	15.1	9.51	78
		01	18	1992	33.0	3.88	23	34.7	5.50	26	13.2	6.26	24	15.5	10.02	26
		01	19	2000	30.7	5.87	66	30.5	6.95	54	11.2	9.47	66	9.6	8.29	54
		03	24	2001	40.8	2.32	32	40.4	3.08	29			0			0
		04	27	1991	38.6	3.29	23	40.0	2.76	16	28.3	15.42	23	33.2	11.66	16
		06	08	1989	32.9	3.86	108	32.5	4.39	72	25.1	13.87	35	20.3	9.62	15
		07	07	1988	32.7	4.58	137	31.7	4.33	95	26.7	12.58	138	22.5	10.15	95
		07	07	1991	36.8	4.38	31	35.5	5.24	29	25.1	15.30	31	22.9	14.36	29
		07	07	1993	35.2	2.24	24	35.3	2.78	33						
		07	07	1996	39.3	3.17	27	39.8	4.20	23			0			0
	Research	01	13	1988	31.0	5.35	191	31.3	5.21	202	17.8	6.89	81	18.2	7.41	88
longline	Commercial	01	12	1991	31.5	5.40	54	29.9	4.56	45	15.9	9.32	55	13.4	5.70	45
		01	12	1994	36.2	4.49	30	36.5	4.18	22	24.0	17.76	30	21.5	13.75	22
		01	12	1998	32.4	3.50	11	32.7	2.36	12			0			0
		04	27	1992	40.9	1.58	36	40.5	1.86	23	31.1	14.17	12	28.4	10.12	10
		05	09	1995	34.8	2.65	26	34.9	2.40	26	34.5	15.23	26	36.0	13.77	26
		05	11	1992	38.3	2.66	26	38.2	3.59	23			0			0

Quillback rockfish (*Sebastes maliger*)					Males			Females			Males			Females		
Gear	Fishery	Major	Minor	Year	Length	std	n	Length	std	n	Age	std	n	Age	std	n
		05	11	1993	41.5	2.25	28	41.3	2.79	21	34.9	14.93	28	39.6	15.74	21
		05	11	1994	34.2	1.69	24	32.8	2.15	26			0			0
		06	08	1992	40.6	2.17	61	40.8	2.55	68	32.0	14.64	61	33.6	16.45	68
		06	08	1993	36.7	3.60	48	35.1	5.11	52	32.0	16.77	48	26.7	15.62	52
		06	08	1994	35.5	3.33	32	34.8	3.26	18			0			0
		06	08	1995	36.0	2.37	25	36.3	2.79	25			0			0
		07	02	1995	33.7	2.46	11	34.2	2.77	21	26.9	9.31	11	31.2	8.81	21
		07	07	1993	34.4	2.71	188	34.0	2.94	241			0			0
		07	07	1996	37.2	3.90	95	37.2	4.30	77			0			0
		08	04	1992	38.2	3.03	40	40.1	3.28	26	40.1	18.24	40	46.8	13.91	26
		08	04	1993	36.5	2.41	95	36.0	3.25	86			0			0
		08	04	2000	38.3	3.23	60	38.7	5.10	64	30.6	15.15	60	31.4	16.45	64
		08	05	1994	33.0	3.37	25	33.6	4.42	26	18.2	8.08	25	18.9	6.9	26
		08	05	1995	36.5	2.79	30	35.7	2.77	18	34.9	14.87	30	32.1	16.80	18
	Charter	05	11	1997	39.1	3.18	12	39.0	4.45	13			0			0
	observed	07	02	1993	34.0	2.64	829	34.1	3.36	814	29.9	14.23	66	29.4	12.86	29
troll	commercial	01	17	1991	35.0	3.65	15	36.0	5.00	37	23.3	8.57	15	26.0	13.05	37
		01	17	1993	30.0	4.19	112	31.3	4.88	166	13.6	5.51	21	14.6	6.97	30
		01	17	2001	30.5	4.71	72	31.1	4.55	53			0			0
		01	18	1991	31.9	3.29	17	30.6	4.95	27	10.5	3.04	17	12.2	9.79	27
		01	18	1992	29.0	3.22	21	30.9	4.99	27	10.1	4.48	21	13.0	8.71	27

Table 19d. Yelloweye rockfish (*Sebastes ruberrimus*) mean length (centimetres) and mean age (years) by sex, gear type, fishery type, Major and Minor area and year.

Yelloweye rockfish (*Sebastes ruberrimus*)					Males			Females			Males			Females		
Gear	Fishery	Major	Minor	Year	Length	std	n	Length	std	n	Age	std	n	Age	Std	n
BT trawl	commercial	05	11	1992	61.7	8.48	27	61.9	8.36	32	39.9	19.90	22	52.0	21.25	28
		06	08	1994	54.3	10.30	26	54.3	10.01	23			0			0
	research	03	24	1991	57.3	9.53	11						0			
	observed	04	25	1999	58.5	7.02	16	52.2	10.17	17			0			0
		04	25	2001	49.8	5.11	15	47.4	5.82	12			0			0
		06	08	1998	58.3	8.88	25	55.2	7.37	25			0			0
		06	08	1999	55.7	9.23	80	52.0	7.70	170			0			0
		06	08	2001	58.4	6.04	36	55.8	5.67	27			0			0
		07	07	1999	49.5	10.11	17	49.9	9.16	19			0			0
		07	07	2001	49.1	8.29	21	48.0	7.78	31			0			0

Yelloweye rockfish (*Sebastes ruberrimus*)					Males			Females			Males			Females		
Gear	Fishery	Major	Minor	Year	Length	std	n	Length	std	n	Age	std	n	Age	Std	n
handline	commercial	01	17	2000	51.3	9.36	24	48.7	12.23	17	16.5	2.12	2			0
		07	06	1996	58.2	7.79	112	58.0	7.99	128			0			0
		07	06	1997	54.7	8.03	144	53.8	7.09	181			0			0
		09	31	1996	54.1	9.16	53	53.0	9.15	46			0			0
		09	31	1997	58.4	6.95	23	58.1	5.50	27			0			0
longline	commercial	00	00	1995	52.1	9.21	145	51.3	8.11	159			0			0
		01	12	1994	47.6	8.77	25	45.3	12.55	25	15.4	15.25	25	18.68	16.03	25
		01	16	1989	60.6	4.66	42	60.6	3.80	32			0			0
		01	17	1988	48.6	8.34	110	47.5	7.43	115	31.9	12.10	110	33.4	11.30	115
		03	23	1996	47.6	8.54	33	44.7	8.30	35			0			0
		03	24	1989	55.0	6.59	24	55.6	8.02	33	26.5	10.10	24	32.7	15.81	33
		03	24	1990	56.3	5.30	39	56.5	4.14	24			0			0
		03	24	1992	52.0	9.71	56	54.5	10.39	43	26.1	17.43	27	36.9	22.45	23
		03	24	1993	52.9	7.48	27	52.5	6.06	26	27.2	15.09	27	29.0	14.29	26
		03	24	1996	47.7	8.97	29	43.2	10.56	31			0			0
		04	25	1988	53.9	8.14	36	55.9	6.77	63	29.3	12.80	36	34.0	12.47	63
		04	25	1989	53.0	10.40	25	52.7	8.23	25	27.9	13.58	25	31.5	14.77	25
		04	25	1999	52.3	6.08	20	49.6	5.34	27	23.7	13.96	20	21.6	6.48	27
		04	26	1991	61.3	6.98	13	57.2	4.49	17			0			0
		04	26	1992	60.7	3.44	31	59.4	3.51	49	43.5	13.48	31	45.2	13.92	49
		04	27	1991	50.9	9.36	28	52.1	9.14	44	23.1	14.21	17	32.4	14.94	33
		04	27	1992	52.3	8.61	43	51.2	10.79	45			0			0
		04	27	1993	56.3	9.59	23	53.7	9.80	27	28.6	14.48	23	28.3	18.72	27
		04	27	1994	53.1	9.85	376	53.8	8.05	397	27.6	12.94	142	28.8	14.03	156
		05	11	1989	56.7	5.77	40	55.5	6.23	60	32.5	14.81	40	38.9	18.88	60
		05	11	1991	52.9	6.25	30	57.1	6.53	22	20.9	8.82	30	39.1	23.37	22
		05	11	1992	43.9	7.72	11	45.8	8.70	14			0			0
		05	11	1993	56.1	5.89	47	48.4	8.95	138			0			0
		05	11	1995	53.7	7.77	16	56.6	9.50	20	21.0	9.67	15	31.5	19.92	19
		05	11	1996	53.8	8.86	22	51.8	9.00	17			0			0
		05	11	2000	49.8	5.66	136	49.5	7.08	186	20.7	6.78	136	24.4	11.75	186
		06	08	1991	59.0	5.43	54	57.5	7.35	45	41.2	17.06	54	49.0	20.32	45
		06	08	1992	56.2	6.54	23	52.7	6.46	29	20.4	11.03	23	23.4	16.04	29
		06	08	1994	59.3	6.35	34	58.3	7.20	66	25.7	9.14	34	30.5	11.29	66
		06	08	1997	49.8	7.09	48	47.4	7.14	92			0			0
		06	08	1999	47.2	7.73	65	46.7	7.74	96	21.7	9.80	65	21.9	13.76	95
		06	08	2001	49.0	7.05	55	46.7	5.86	45	24.1	10.12	55	22.7	9.38	45
		07	02	1990	55.2	19.46	67	57.7	11.76	33	51.8	23.01	53	55.9	27.46	25

Yelloweye rockfish (*Sebastes ruberrimus*)				Males			Females			Males			Females		
Gear	Fishery	Major	Minor	Year	Length	std	n	Length	std	n	Age	std	n	Age	Std	n
		07	02	1994	61.6	7.75	11	57.1	12.01	39			0			0
		07	02	1995	59.9	9.55	35	60.9	8.56	65	31.5	16.29	35	41.6	19.84	65
		07	06	1993	53.7	6.63	29	54.4	6.96	38			0			0
		07	06	1995	52.3	10.32	46	50.2	8.99	54	21.1	12.86	21	29.8	19.82	29
		07	06	1997	57.1	4.82	39	55.5	5.04	61			0			0
		07	07	1990	57.5	7.80	62	55.3	7.54	37			0			0
		07	07	1991				64.1	3.82	11						0
		07	07	1994	50.5	9.57	76	51.0	8.70	113			0			0
		07	07	1996	47.7	11.36	92	47.9	9.95	89			0			0
		07	07	1997	52.3	7.41	23	53.9	6.44	28			0			0
		07	07	2000	50.8	7.55	99	48.5	7.39	101	28.4	12.96	99	30.3	14.67	100
		08	04	1996	56.7	8.66	99	57.4	8.80	133	24.0	9.58	21	35.2	21.86	31
		08	04	1997	57.6	10.70	23	61.7	7.22	27			0			0
		09	00	1999	51.3	7.40	76	53.0	7.45	89	21.4	11.11	76	25.8	14.60	89
		09	31	1994	56.5	8.64	186	56.3	7.99	337	33.3	13.80	82	35.2	16.04	112
		09	31	1995	58.4	8.57	28	59.9	9.14	32			0			0
		09	31	1996	54.4	7.73	88	55.9	8.40	119			0			0
		09	31	1997	53.1	10.07	41	55.9	10.46	54			0			0
		09	31	1999	54.1	11.60	549	54.5	12.29	638	26.2	16.02	248	29.3	19.58	233
		09	31	2000	51.2	5.87	85	52.9	6.92	115	20.6	7.63	85	28.5	16.12	115
		09	34	1994	62.3	6.89	33	60.6	6.93	42	31.6	17.58	33	32.5	14.67	42
		09	34	1999	51.2	7.62	344	49.8	8.91	325	24.6	13.93	191	24.1	12.84	157
		09	34	2000	51.5	6.57	33	52.5	7.41	42	21.1	7.46	33	23.9	13.06	42
		09	35	1994	60.0	8.21	32	60.4	6.91	62	43.3	18.35	16	47.7	18.56	29
		09	35	1995	56.4	6.20	24	54.6	5.30	26			0			0
		09	35	1996	54.8	7.20	22	57.4	4.62	28			0			0
		10	32	1999	55.1	5.79	39	54.8	6.57	55	26.8	5.94	23	30.6	12.98	23
	charter	00	00	1998	52.8	5.65	39	51.8	9.23	32	21.3	4.95	39	26.2	18.06	32
		04	27	1997	45.7	7.05	51	44.4	7.43	69	18.8	6.32	51	19.5	9.44	69
		04	27	1998	45.7	5.05	74	44.8	6.31	44	19.5	3.29	74	19.9	3.77	44
		05	11	1997	52.9	7.23	166	53.3	7.68	299	27.8	14.63	166	35.4	18.75	299
		05	11	1998	49.7	7.31	375	49.2	7.74	281	23.1	9.61	375	26.7	14.31	281
		09	31	1997	55.5	8.20	112	53.2	9.23	215	29.6	16.12	123	31.0	20.14	238
		09	31	1998	53.5	8.89	161	50.9	8.33	173	25.6	13.34	161	26.0	15.41	173
		09	31	2000	49.3	10.35	100	51.2	9.87	119	18.0	7.74	72	23.0	16.63	88
		09	34	1997	56.7	7.89	149	52.8	9.11	246	30.9	15.93	148	30.6	18.25	246
		09	34	1998	56.0	7.62	307	54.7	8.21	280	28.4	13.73	307	31.0	17.50	280
		09	34	2000	53.0	6.49	177	53.3	7.92	186	24.4	10.57	124	35.2	23.47	129

Yelloweye rockfish (*Sebastes ruberrimus*)					Males			Females			Males			Females		
Gear	Fishery	Major	Minor	Year	Length	std	n	Length	std	n	Age	std	n	Age	Std	n
	observed	07	02	1993	51.4	12.81	39	55.5	11.65	27	24.7	18.16	39	32.2	19.19	27
		09	31	1992	53.4	16.50	252	49.8	17.71	312	26.5	12.57	118	25.5	12.21	157
		09	31	1994	5.0	1.34	11	5.6	0.80	17			0			0
troll	commercial	01	17	1993	33.7	3.79	13									

Table 20. Estimates of growth and total mortality.

Yelloweye rockfish von Bertalanffy (1938) growth parameters.

Site	male			female		
	L_∞	k	t_0	L_∞	k	t_0
Bowie	80.2	0.043	6.7	84.6	0.031	11.0
Tasu	70.9	0.04	12.0	67.6	0.051	6.4
St. James	68.7	0.057	4.7	66.8	0.059	3.7
Triangle	65.5	0.061	2.5	64.4	0.049	6.3
TopKnot	68.4	0.044	7.6	67.8	0.042	7.8

Quillback rockfish von Bertalanffy growth parameters.

PFMA	male			female		
	L_∞	k	t_0	L_∞	k	t_0
Area 12	39.1	0.1	3.2	41.7	0.064	7.4
Area 13	39.0	0.093	4.0	41.5	0.069	6.4
Area 17	37.9	0.13	2.1	40.2	0.1	6.4
Area 18	39.6	0.14	2.4	41.8	0.11	3.6

Yelloweye rockfish maximum age and Total Mortality Estimates Z_h (Hoenig 1983)

Site	male		female	
	t_{max}	Z_h	t_{max}	Z_h
Bowie	92	0.049	99	0.046
Tasu	87	0.053	115	0.04
Anthony Is.	95	0.048	97	0.047
Triangle	84	0.054	98	0.047
TopKnot	48	0.094	66	0.068
Str. Geo.	86	0.053	74	0.062
SW Van. Is.	78	0.059	80	0.057
Hecate Str.	97	0.047	105	0.044

Quillback rockfish maximum age and Total Mortality Estimates Z_h (Hoenig 1983)

Area	male		female	
	t_{max}	Z_h	t_{max}	Z_h
Str. Geo.	65	0.07	70	0.065
QC Sound	76	0.06	95	0.048

Table 21a. Yelloweye rockfish total mortality estimates (Z) and total mortality estimated over the 20 to 60 year age classes ($Z_{20\text{-}60}$), catch curve analysis (Ricker 1975) by sex.

Site	male		female	
	Z	$Z_{20\text{-}60}$	Z	$Z_{20\text{-}60}$
Bowie	0.0195	0.0146	0.00976	0.00781
Tasu	0.0391	0.0619	0.0288	0.0525
Anthony Is.	0.0449	0.0553	0.0368	0.0516
Triangle	0.0458	0.0661	0.0345	0.0366
TopKnot	0.0799	0.0799	0.0405	0.0405

Table 21b. Yelloweye rockfish total mortality estimates (Z) and total mortality estimated over the 20 to 60 year age classes ($Z_{20\text{-}60}$), catch curve analysis (Ricker 1975), by year with sexes combined.

Site	combined sexes	
	Z	$Z_{20\text{-}60}$
1997/98		
Tasu	0.0394	0.0601
Anthony Is.	0.0456	0.0532
Triangle	0.0447	0.0477
TopKnot	0.0659	0.0659
1999		
Bowie	0.0195	0.0237
Anthony Is.	0.023	0.0467
2000		
Tasu	0.0256	0.0414
Anthony Is.	0.0173	0.0325
Triangle	0.0297	0.0401
TopKnot	0.0382	0.0532

Table 22a. Quillback rockfish total mortality estimates (Z) and total mortality estimated over the 12 to 40 year age classes ($Z_{12\text{-}40}$), catch curve analysis (Ricker 1975) by sex and year.

PFMA	male		female	
12 survey	Z	$Z_{12\text{-}40}$	Z	$Z_{12\text{-}40}$
1986	0.0389	0.0318	0.0256	0.0171
1987	0.0375	0.0389	0.0352	0.0373
1988	0.0235	0.035	0.0295	0.0421
1992	0.0417	0.0451	0.0242	0.0204
2001	0.0589	0.0921	0.0732	0.105

Table 22b. Quillback rockfish total mortality estimates (Z) and total mortality estimated over the 12 to 40 year age classes ($Z_{12\text{-}40}$), catch curve analysis (Ricker 1975), by year with sexes combined.

PFMA	combined sexes	
	Z	$Z_{12\text{-}40}$
12 survey		
1986	0.0474	0.0309
1987	0.0463	0.0608
1988	0.0412	0.0596
1992	0.0387	0.0364
2001	0.0739	0.119
18-19 survey		
1998	0.0477	0.067

commercial		combined sexes	
fishery	year	Z	$Z_{20\text{-}60}$
Area 12	1984	0.0153	
Area 13	1984	0.082	0.088
Area 13	1986	0.0709	0.0946
Area 17	1986	0.0781	0.099
Area 18	1988	0.0705	0.0887

Table 23. Genetic diversity in yelloweye rockfish samples from Alaska and British Columbia. Expected heterozygosity based on observed allele frequencies (H_E), observed heterozygosity (H_O), and allelic diversity (mean number of alleles observed per locus) are given for each sample.

Sample	Date	N	H_E	H_0	Allelic diversity
Bowie Seamount (D)	July 1998	90	73.9	69.5	12.5
Bowie Seamount (D)	July 1999	170	73.0	71.5	14.2
Bowie Seamount (D)	Aug 1999	90	71.1	69.4	12.5
Bowie Seamount (D)	Sept 1999	90	74.2	71.2	13.3
Bowie Seamount (B)	July 1998	95	73.2	68.7	13.4
Bowie Seamount (B)	July 1999	110	73.3	71.4	13.4
Bowie Seamount (B)	Aug 1999	90	72.4	70.8	12.2
Bowie Seamount (B)	Sept 1999	110	72.5	69.9	13.5
Barber Point (D)	May 1999	100	73.8	71.2	13.5
Barber Point (D)	Sept 1999	65	72.1	68.4	11.8
Barber Point (B)	May 1999	175	72.7	70.9	13.8
Barber Point (B)	Sept 1999	65	72.5	69.9	11.8
Sitka, Alaska	Dec 1999	90	72.1	70.4	12.5
Tasu	May 1998	80	74.0	71.6	12.6
Tasu	Jan 2000	180	73.8	73.7	14.5
Cape St. James	May 1998	85	73.2	69.1	11.9
Cape St. James	Jan 1999	80	71.1	66.6	11.3
Cape St. James	Oct 1999	130	72.3	69.9	13.3
Cape St. James	Feb 2000	65	73.6	73.2	11.7
Triangle Island	May 1998	80	72.0	68.4	12.5
Triangle Island	Jan 2000	145	73.8	68.3	13.9
Topknot	May 1998	85	73.5	70.9	12.1
Topknot	Mar 2000	135	72.1	71.2	13.4
Brooks Bay	Oct 1998	70	73.6	72.0	11.8
Esperanza	Sep 1999	45	73.0	72.1	11.1
Mean		2520	72.9	70.4	12.7

Table 24. Genetic diversity in quillback rockfish samples from British Columbia and Puget Sound. Expected heterozygosity based on observed allele frequencies (H_E), observed heterozygosity (H_O), and allelic diversity (mean number of alleles observed per locus) are given for each sample.

Sample	Date	N	H_E	H_O	Allelic diversity
Stenhouse Reef	Feb 2000	60	70.5	69.6	9.3
Stenhouse Reef	Sept 2000	37	65.7	64.7	8.1
Hecate Strait	May 2000	33	68.9	69.4	7.9
Queen Charlotte Sound	Mar 2001	354	69.6	70.1	12.7
Queen Charlotte Sound	April 2001	144	69.7	71.0	10.9
Gordon Channel	Oct 2000	90	69.1	71.1	9.7
Tofino	Feb 2001	65	68.1	69.5	9.5
Gabriola	Sept 2000	35	71.5	71.1	9.5
Gabriola	May 2001	36	67.1	68.0	8.0
Pylades Channel	Oct 2000	58	70.3	71.4	10.2
Pylades Channel	May 2001	58	68.2	67.0	8.8
Darcy Island	Oct 1998	31	70.9	71.8	7.6
Race Rocks	Sept 2000	54	70.0	71.5	9.6
Cooper Reef	Sept 2000	66	70.9	69.6	9.6
Southern Gulf (Canada)	1997	125	70.4	69.0	11.1
Gulf of Georgia (USA)	1997	62	70.3	68.6	10.1
Port Gardner (Puget S)	1998	12	71.3	69.1	6.3
Foulweather Bluff (PS)	1997	24	69.8	68.6	7.7
Elliot Bay	1998	75	71.0	73.0	10.0
Mean		75	69.6	69.7	9.5

Figure 1. Comparison of annual (1982-2000) recreational a) catch in numbers of fish per 10 boat trips and b) proportions of fish in numbers of salmon and rockfish in the Strait of Georgia Creel Survey.

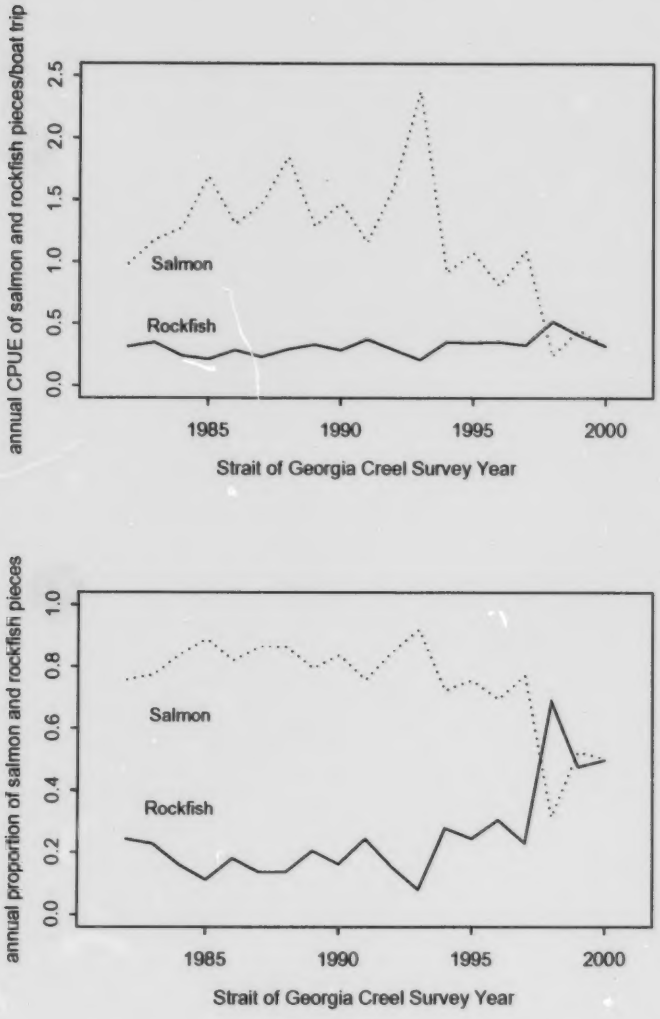

Figure 2. Comparison of estimated rockfish catch from the recreational (grey bar) and commercial (black bar) fisheries in the Strait of Georgia management region by PFMA in four time periods between 1982 and 2000.

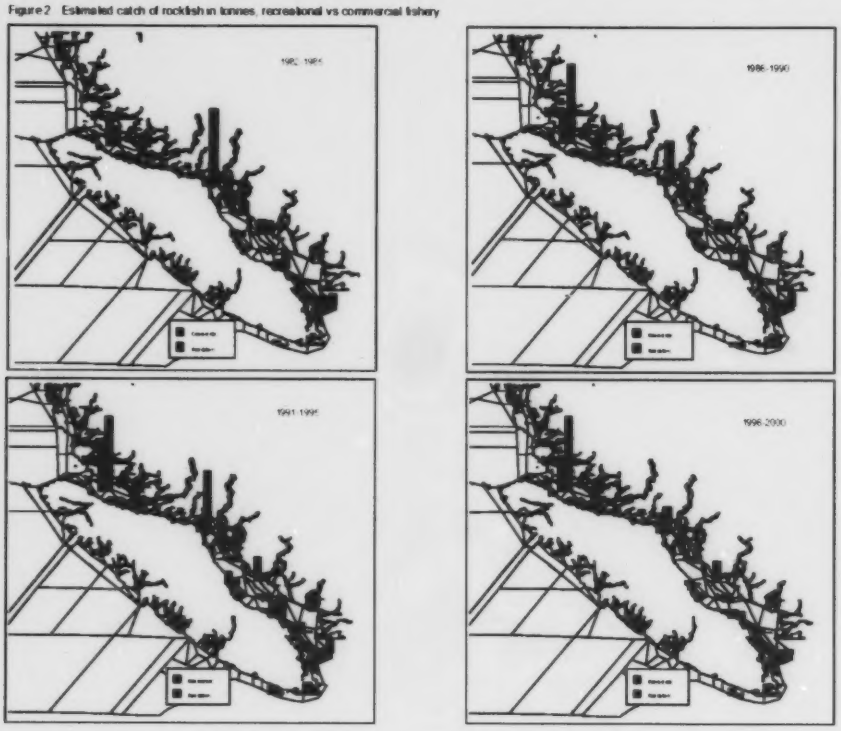

Figure 3. Commercial rockfish fishery (ZN licensed) yelloweye rockfish CPUE in catch per fishing day between 1986 and 2000 by management region. Solid line represents the median, dotted line represents the 3rd quartile and dashed and dotted line represents the 1st quartile. Vertical dotted line shows the year in which limited entry licensing was implemented.

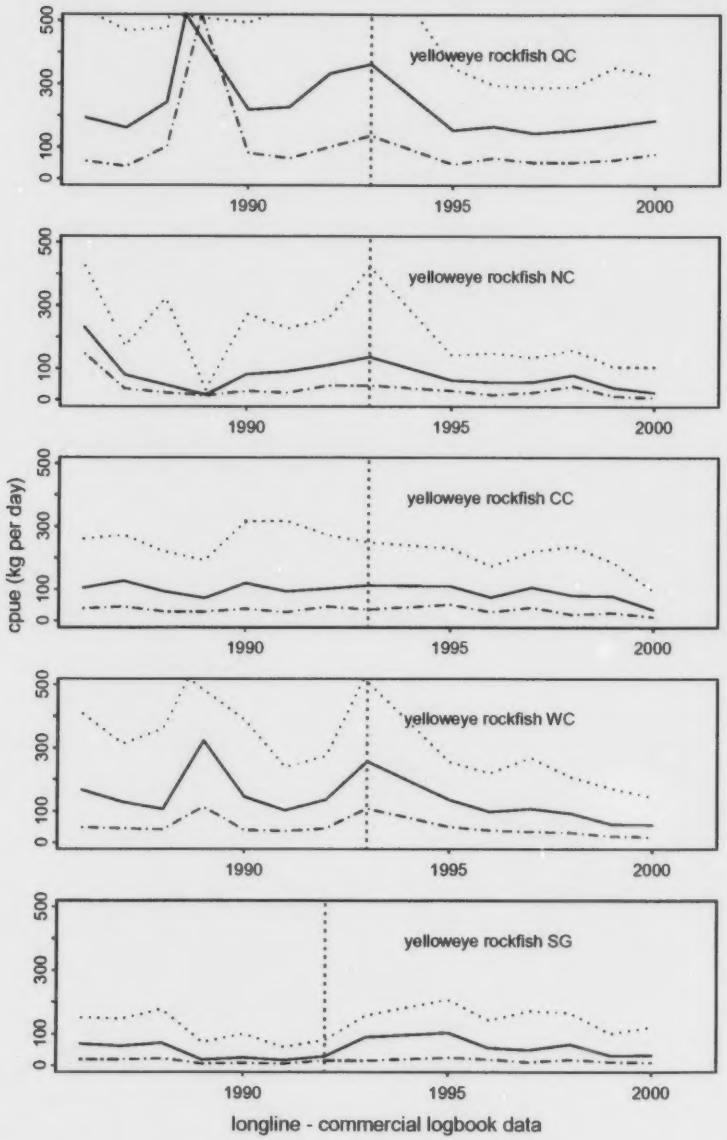

Figure 4. Commercial rockfish fishery (ZN licensed) quillback rockfish CPUE in catch per fishing day between 1986 and 2000 by management region. Solid line represents the median, dotted line represents the 3rd quartile and dashed and dotted line represents the 1st quartile. Vertical dotted line shows the year in which limited entry licensing was implemented.

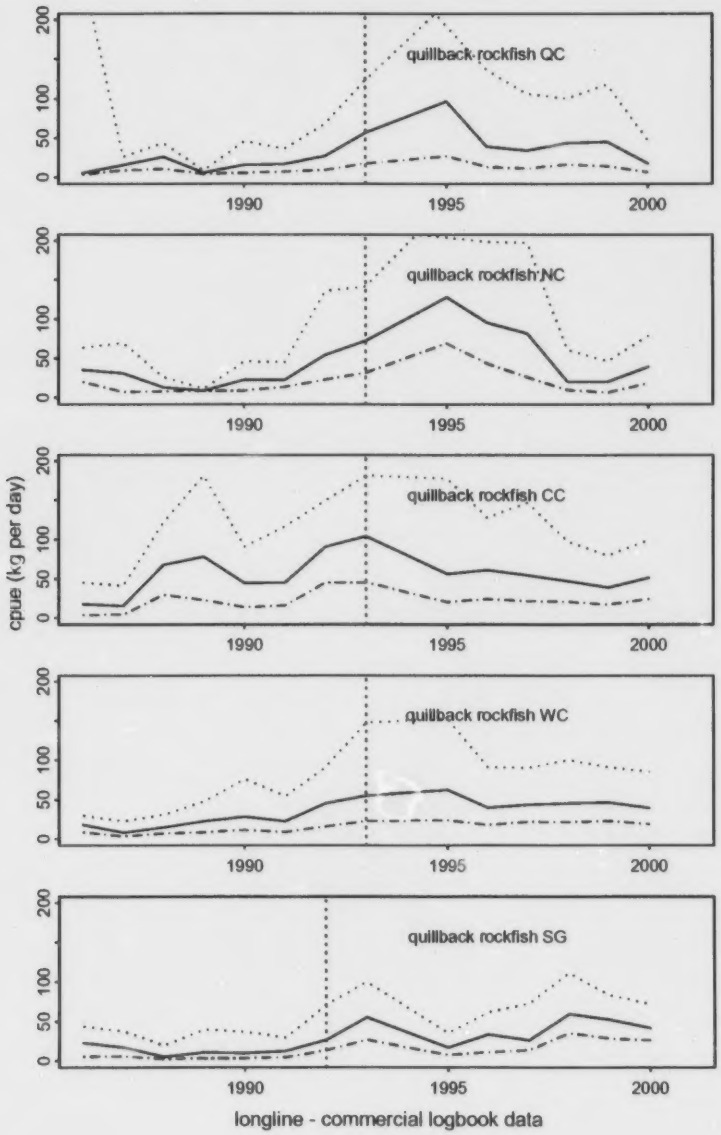

Figure 5. Commercial rockfish fishery (ZN licensed) copper rockfish CPUE in catch per fishing day between 1986 and 2000 by management region. Solid line represents the median, dotted line represents the 3rd quartile and dashed and dotted line represents the 1st quartile. Vertical dotted line shows the year in which limited entry licensing was implemented.

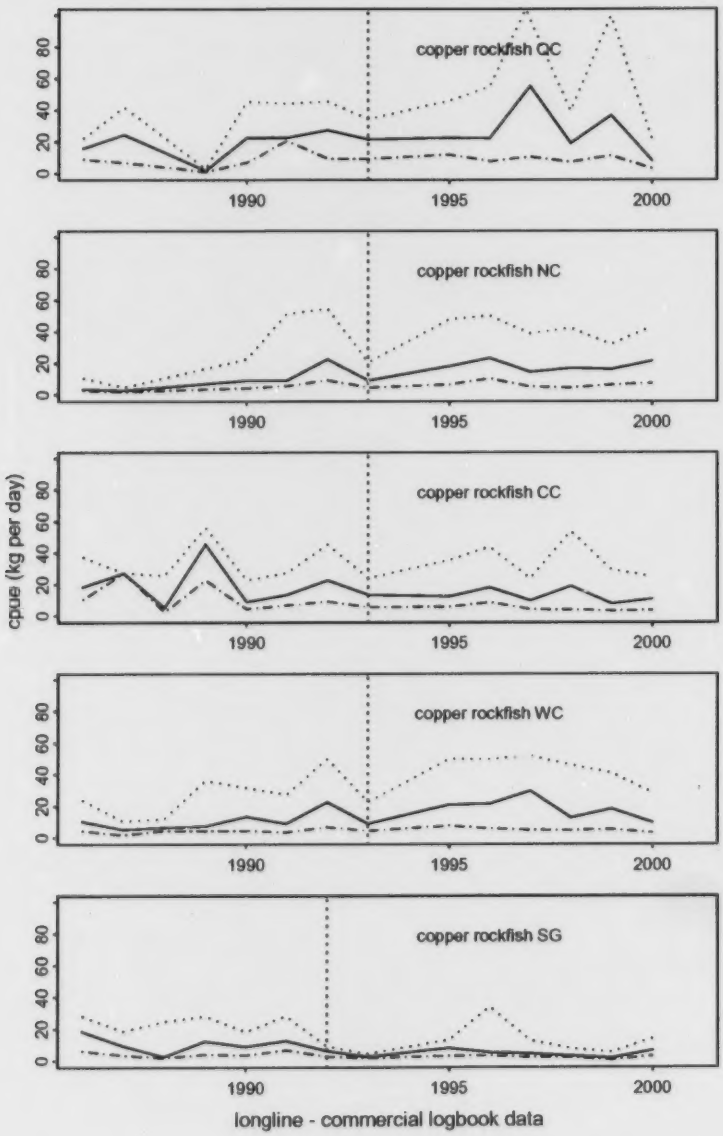

Figure 6. Commercial rockfish fishery (ZN licensed) black rockfish CPUE in catch per fishing day between 1986 and 2000 by management region. Solid line represents the median, dotted line represents the 3rd quartile and dashed and dotted line represents the 1st quartile. Vertical dotted line shows the year in which limited entry licensing was implemented

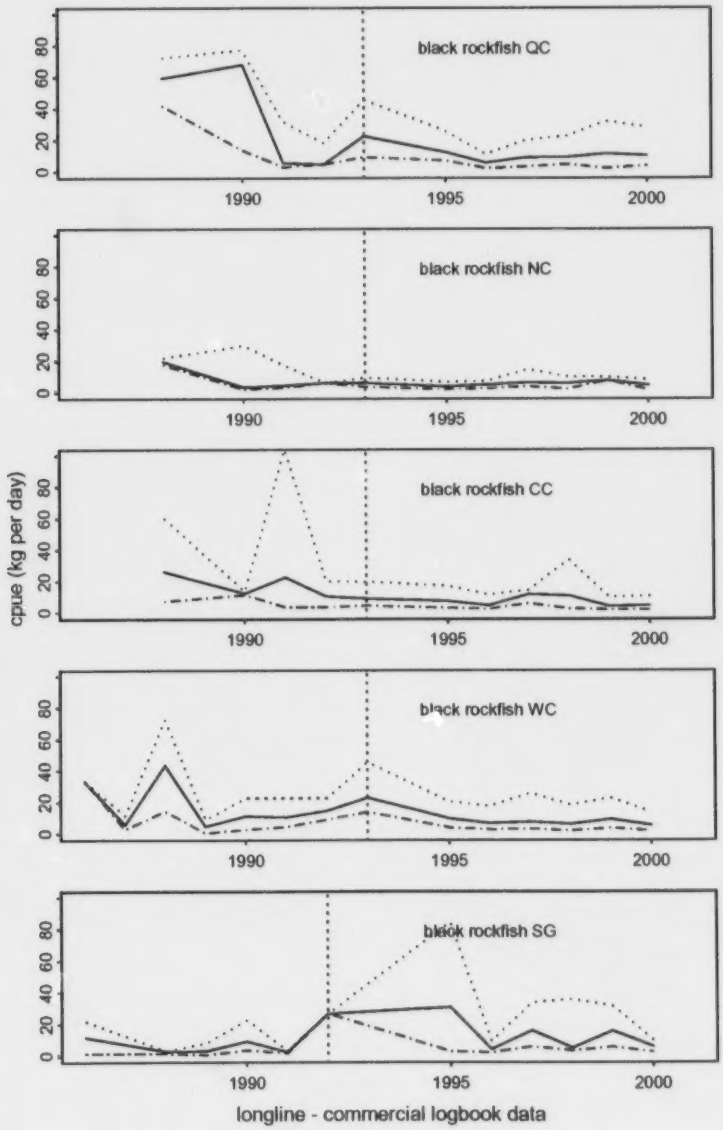

Figure 7. Commercial rockfish fishery (ZN licensed) china rockfish CPUE in catch per fishing day between 1986 and 2000 by management region. Solid line represents the median, dotted line represents the 3rd quartile and dashed and dotted line represents the 1st quartile. Vertical dotted line shows the year in which limited entry licensing was implemented.

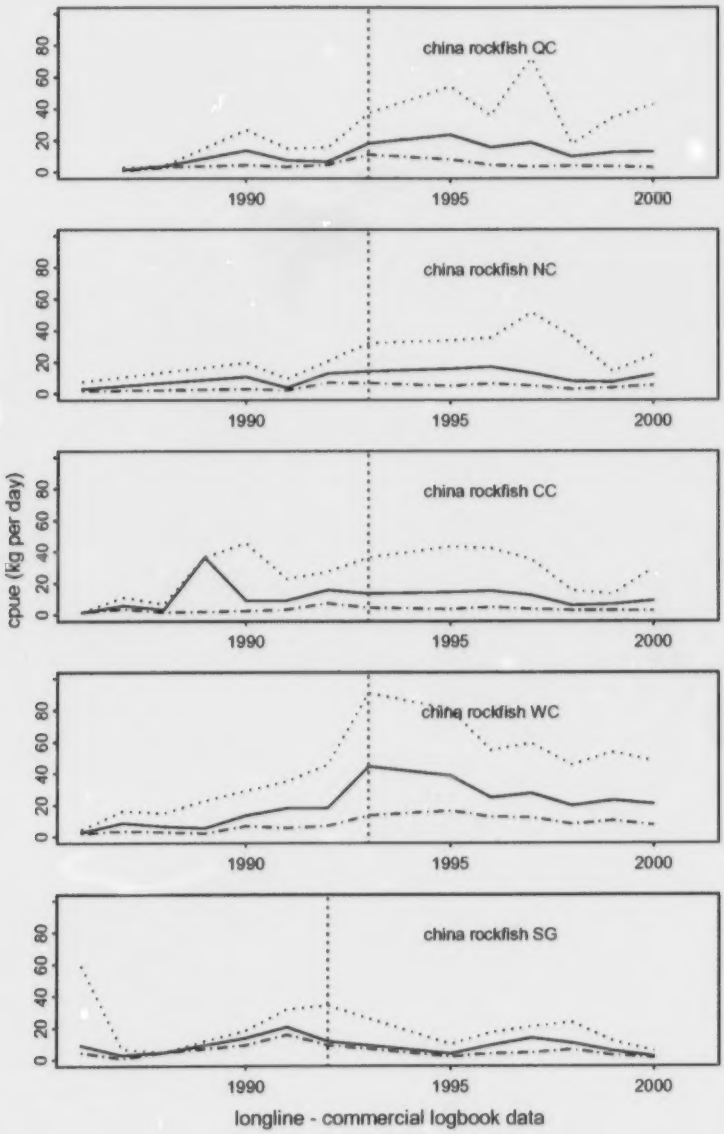

Figure 8. Commercial rockfish fishery (ZN licensed) tiger rockfish CPUE in catch per fishing day between 1986 and 2000 by management region. Solid line represents the median, dotted line represents the 3rd quartile and dashed and dotted line represents the 1st quartile. Vertical dotted line shows the year in which limited entry licensing was implemented.

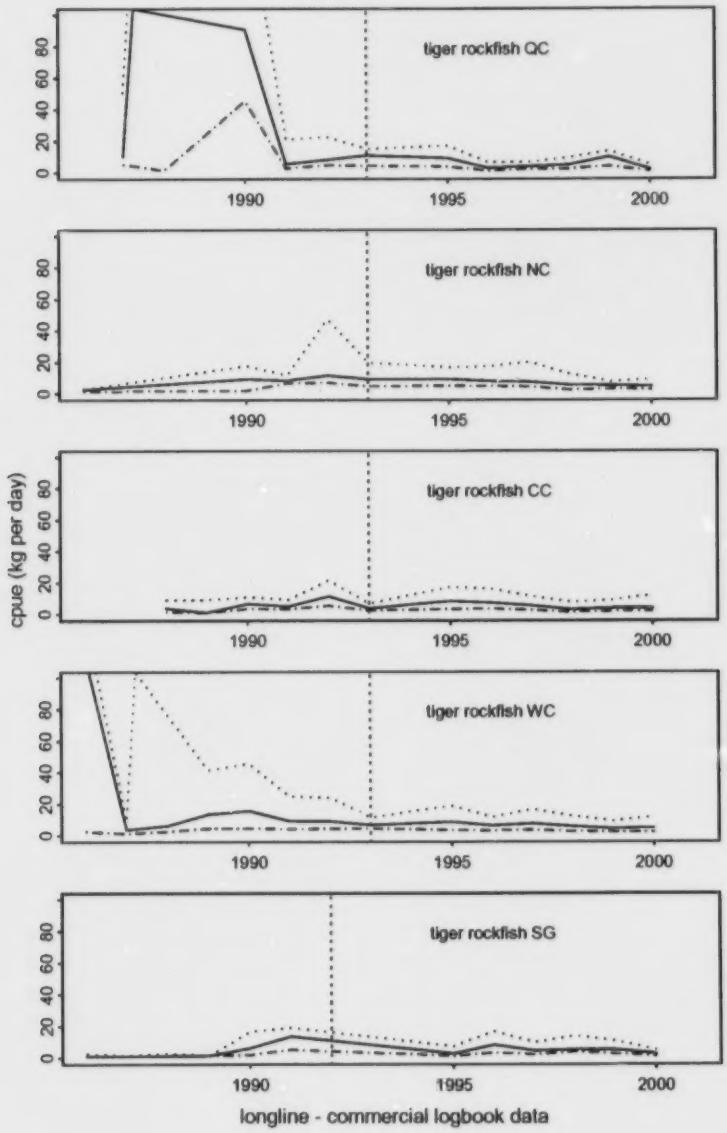

Figure 9. Commercial rockfish fishery (ZN licensed) yelloweye rockfish CPUE in catch per fishing day between 1986 and 2000 in the Strait of Georgia management region by PFMA. Solid line represents the median, dotted line represents the 3rd quartile and dashed and dotted line represents the 1st quartile. Vertical dotted line shows the year in which limited entry licensing was implemented.

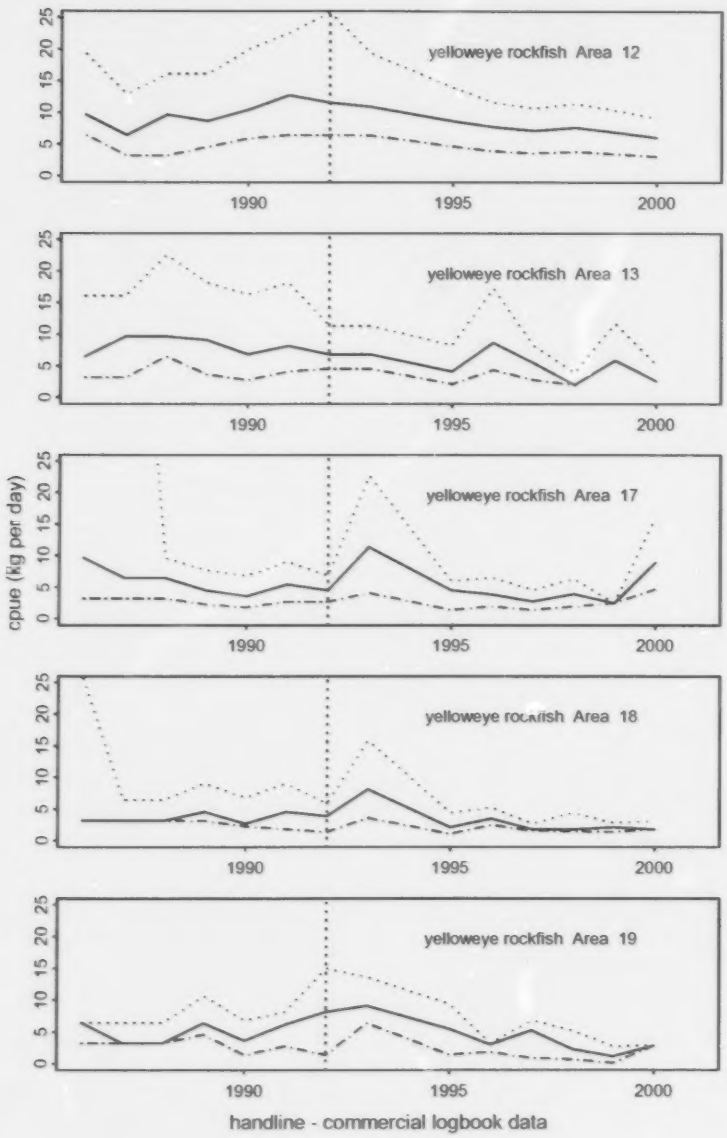

Figure 10. Commercial rockfish fishery (ZN licensed) quillback rockfish CPUE in catch per fishing day between 1986 and 2000 in the Strait of Georgia management region by PFMA. Solid line represents the median, dotted line represents the 3rd quartile and dashed and dotted line represents the 1st quartile. Vertical dotted line shows the year in which limited entry licensing was implemented.

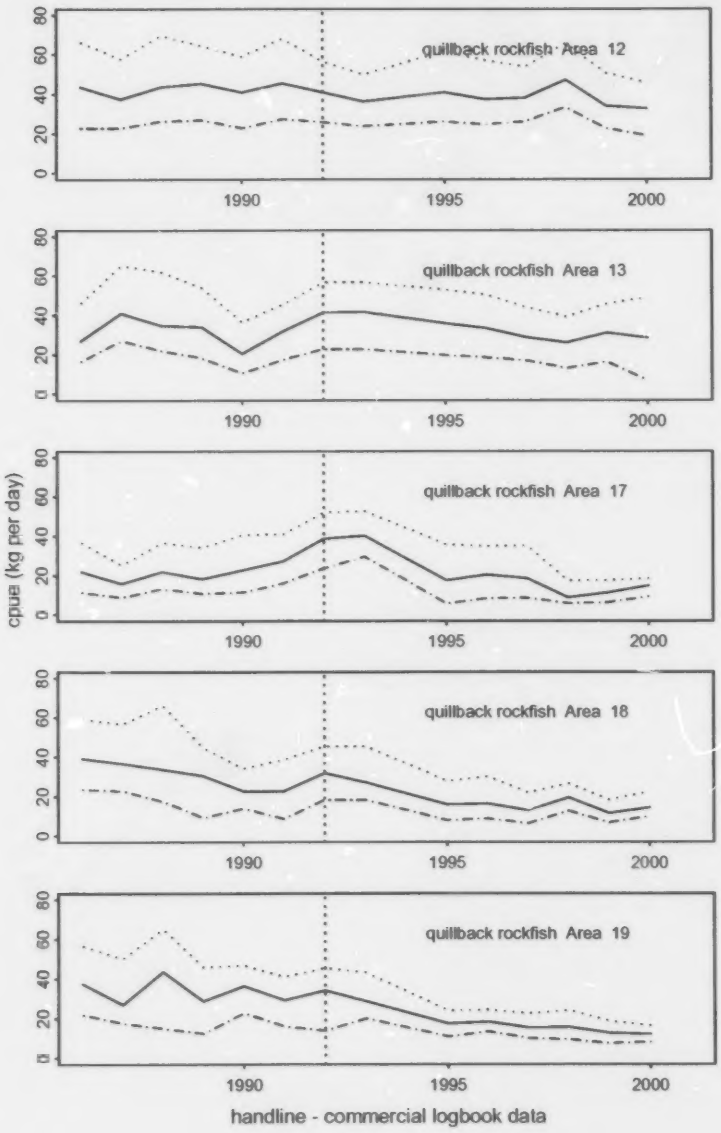

Figure 11. Commercial rockfish fishery (ZN licensed) copper rockfish CPUE in catch per fishing day between 1986 and 2000 in the Strait of Georgia management region by PFMA. Solid line represents the median, dotted line represents the 3rd quartile and dashed and dotted line represents the 1st quartile. Vertical dotted line shows the year in which limited entry licensing was implemented.

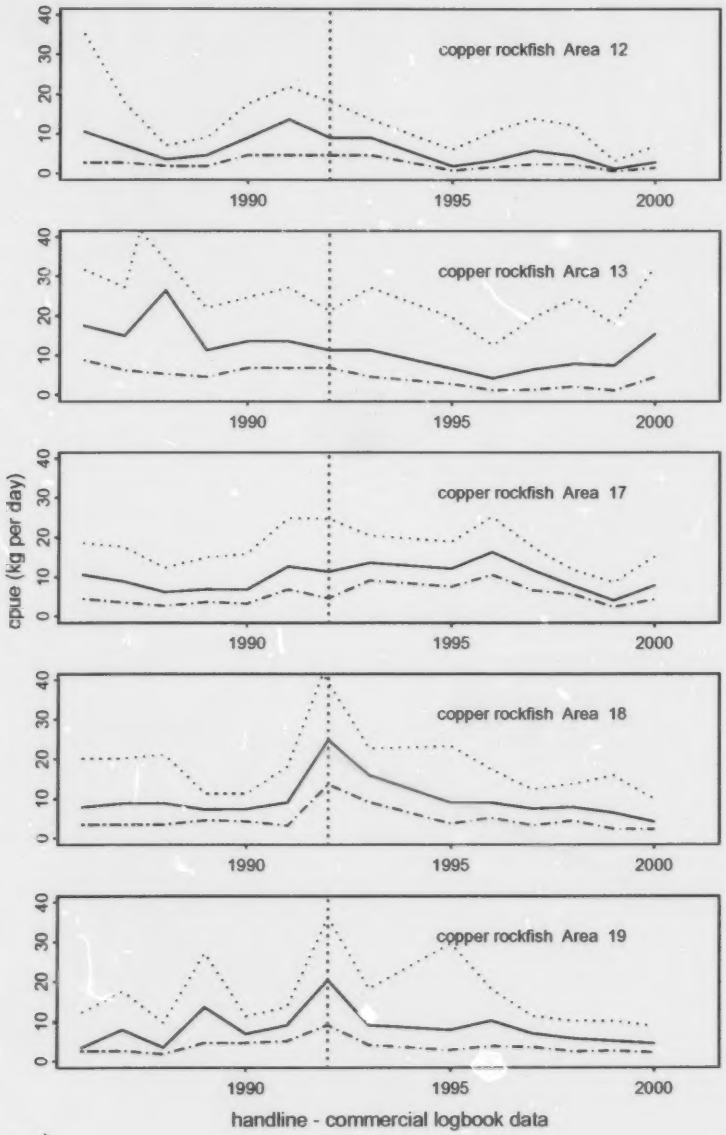

Figure 12. Commercial rockfish fishery (ZN licensed) black rockfish CPUE in catch per fishing day between 1986 and 2000 in the Strait of Georgia management region by PFMA. Solid line represents the median, dotted line represents the 3rd quartile and dashed and dotted line represents the 1st quartile. Vertical dotted line shows the year in which limited entry licensing was implemented.

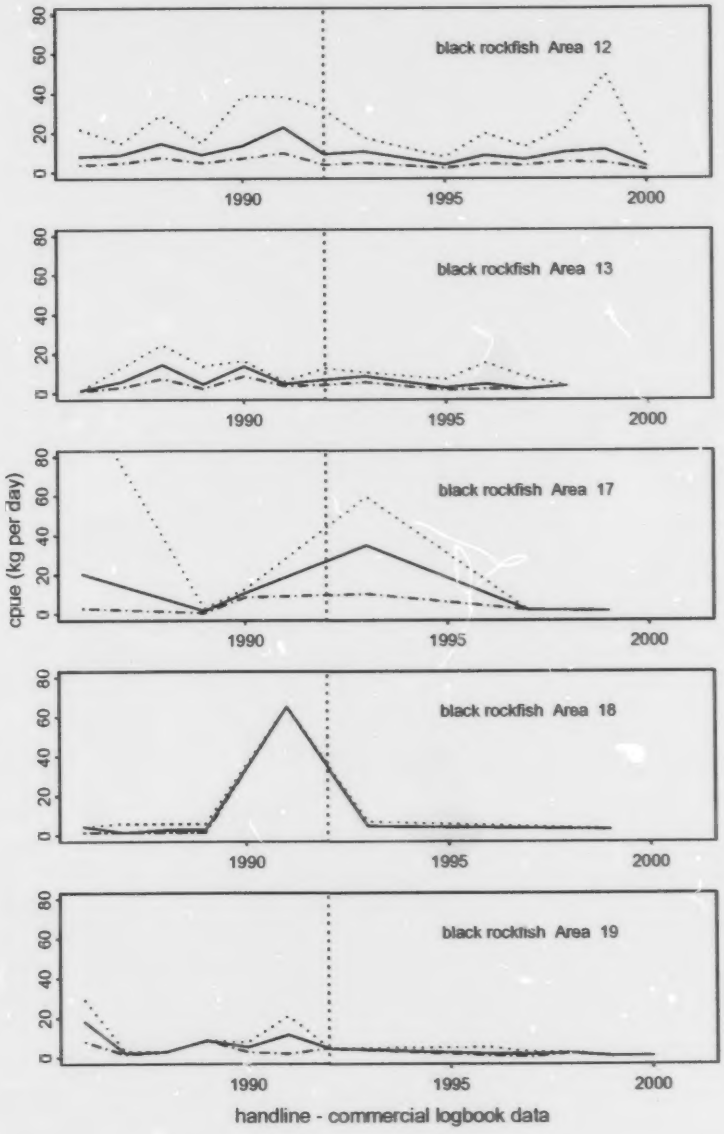

Figure 13. Commercial rockfish fishery (ZN licensed) tiger rockfish CPUE in catch per fishing day between 1986 and 2000 in the Strait of Georgia management region by PFMA. Solid line represents the median, dotted line represents the 3rd quartile and dashed and dotted line represents the 1st quartile. Vertical dotted line shows the year in which limited entry licensing was implemented.

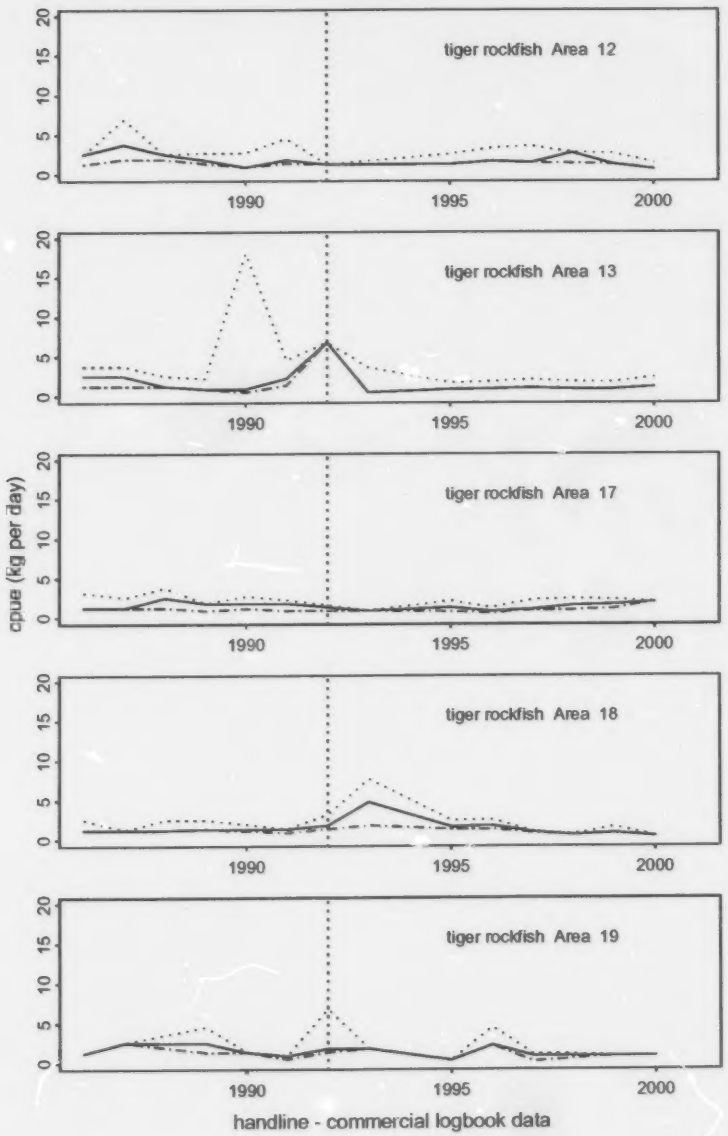

Figure 14. Commercial rockfish fishery (ZN licensed) china rockfish CPUE in catch per fishing day between 1986 and 2000 in the Strait of Georgia management region by PFMA. Solid line represents the median, dotted line represents the 3rd quartile and dashed and dotted line represents the 1st quartile. Vertical dotted line shows the year in which limited entry licensing was implemented.

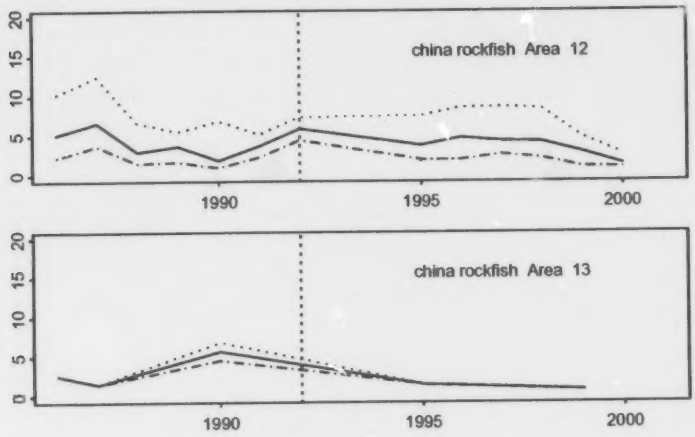

Figure 15. ZN Option A longline commercial quillback rockfish CPUE in catch per fishing day between 1995 and 2000 for outside management regions. Solid line represents the median, dotted line represents the 3rd quartile and dashed and dotted line represents the 1st quartile.

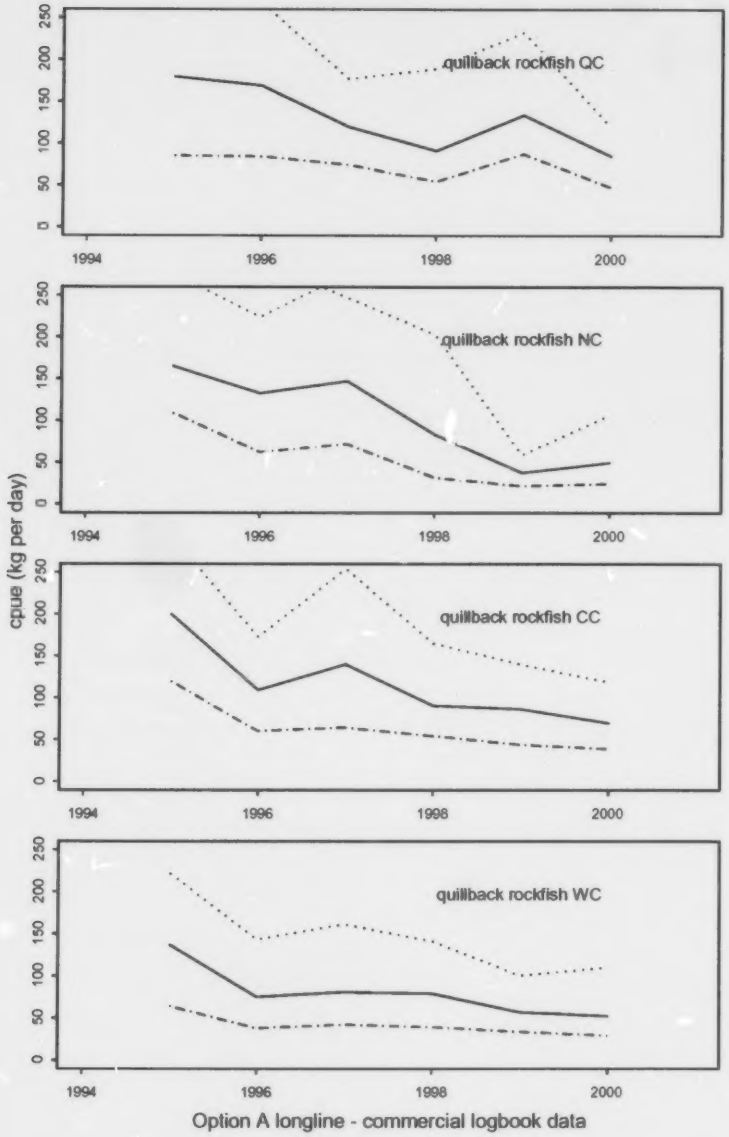

Figure 16. ZN Option B longline commercial yelloweye rockfish CPUE in catch per fishing day between 1995 and 2000 for outside management regions. Solid line represents the median, dotted line represents the 3rd quartile and dashed and dotted line represents the 1st quartile.

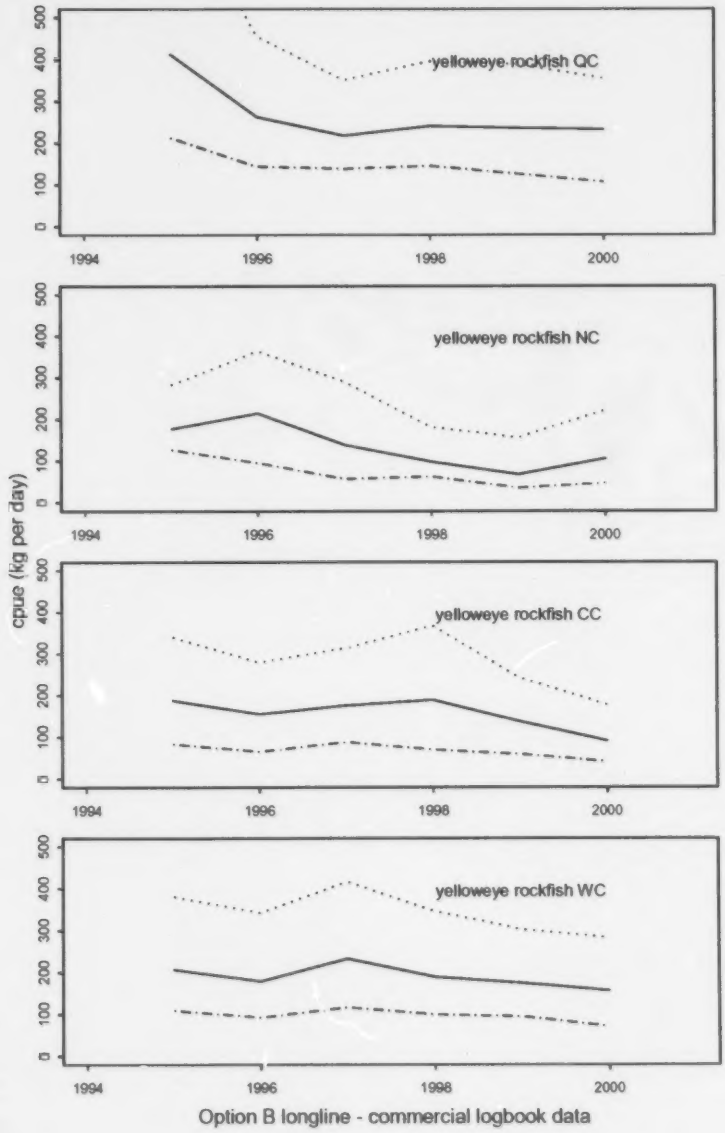

Figure 17. ZN option A (live rockfish) fishing effort (number of sets) summarized by year (a, b and c) in 2.7 square km grid cells in outside management areas.

Figure 17a. Option A grouped numbers of fishing events by 2.7x 2.7 km grids by year.

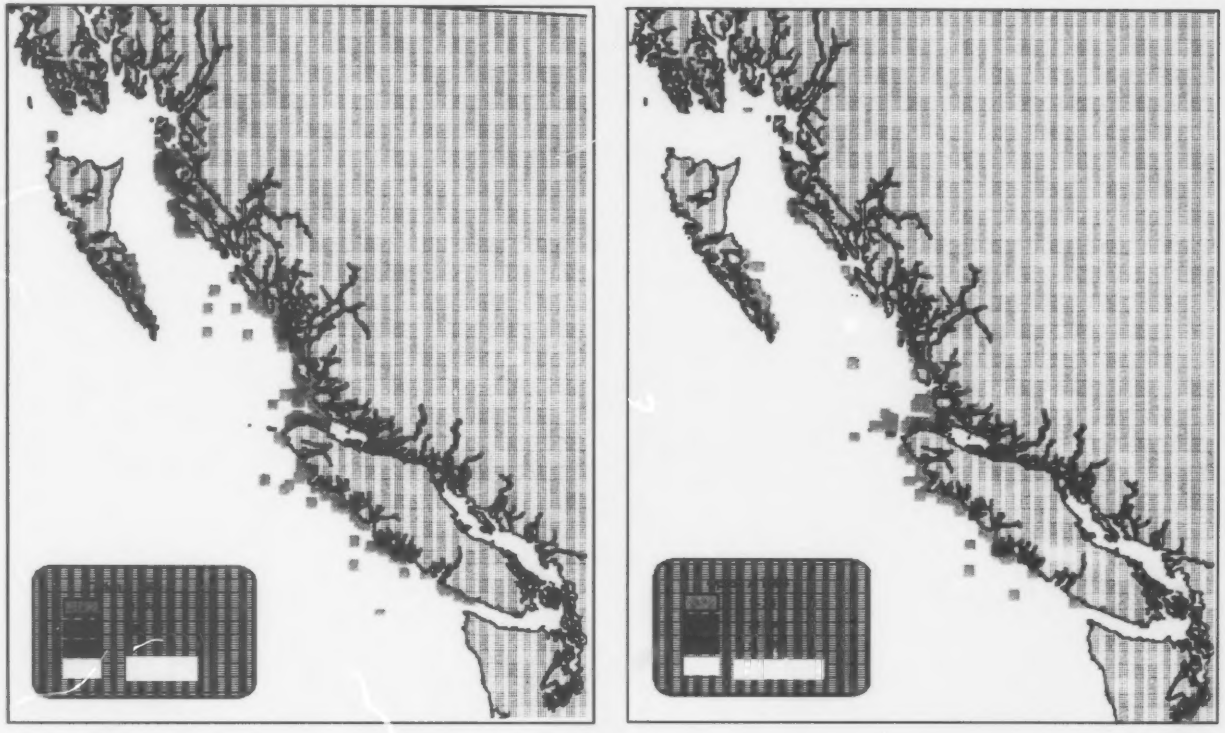

Figure 17b. Option A grouped numbers of fishing events by 2.7x 2.7 km grids by year.

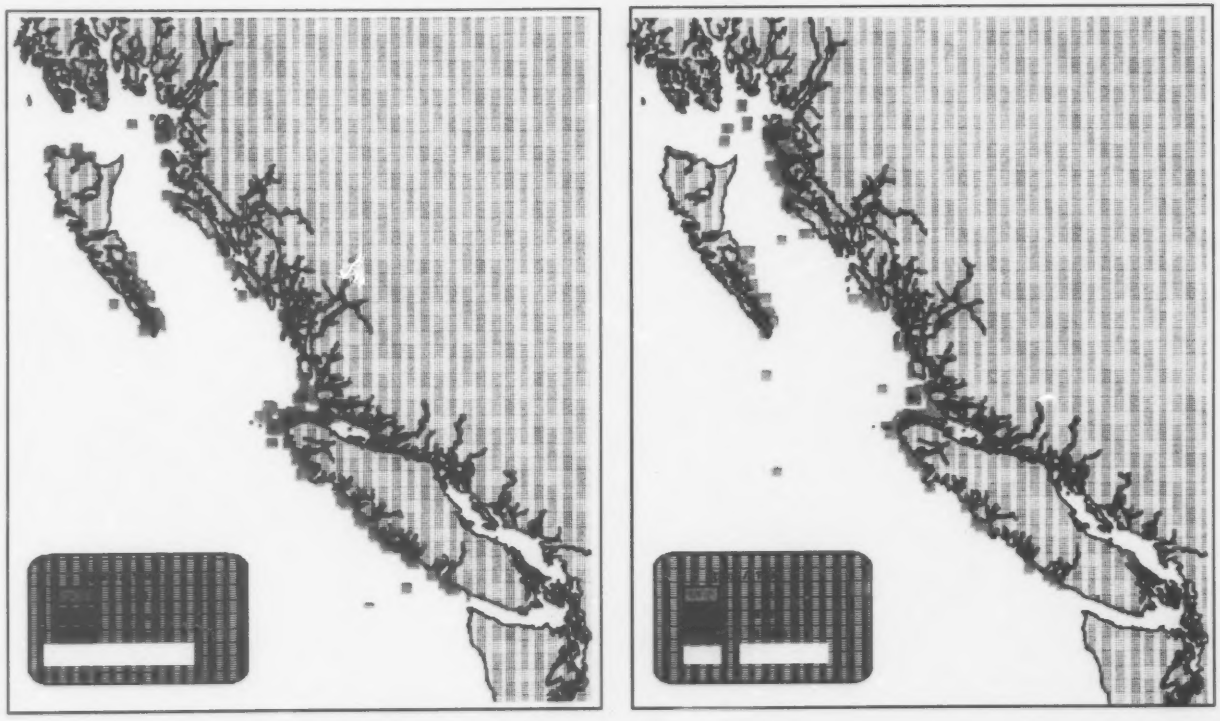

Figure 17c. Option A grouped numbers of fishing events by 2.7x 2.7 km grids by year.

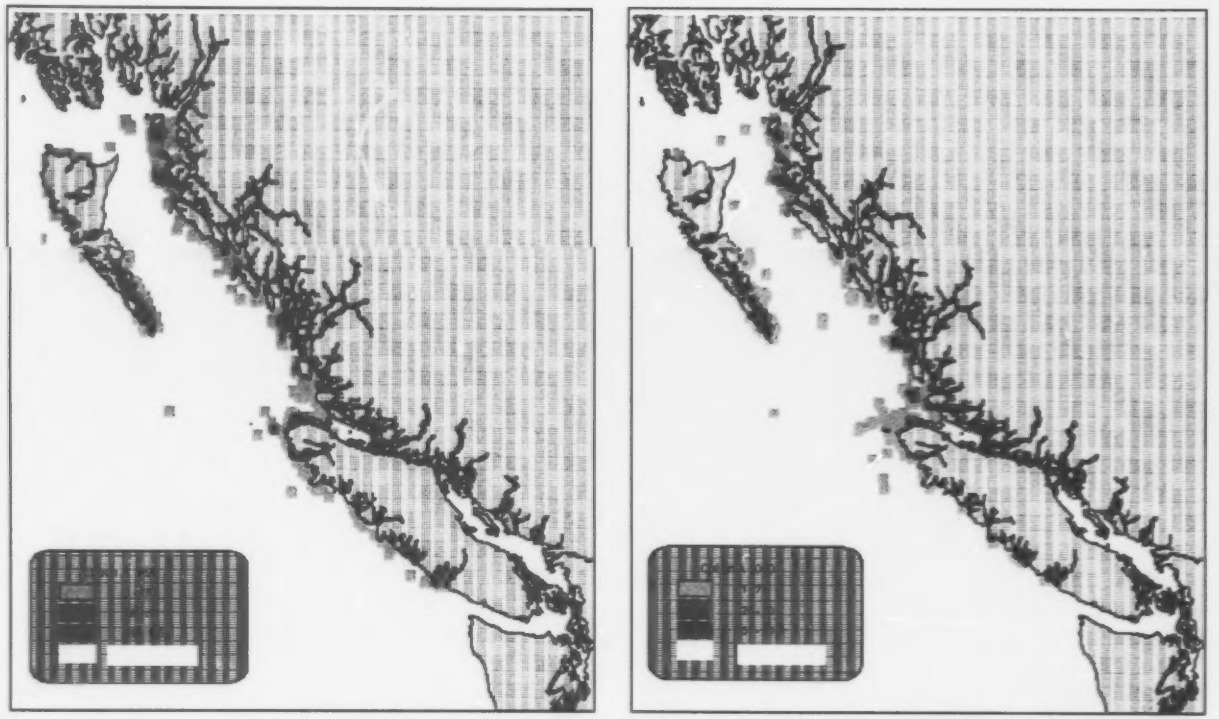

Figure 18. ZN option B (yelloweye rockfish) fishing effort (number of sets) summarized by year (a, b and c) in 2.7 square km grid cells in outside management areas.

Figure 18a. Option B grouped numbers of fishing events by 2.7x 2.7 km grids by year.

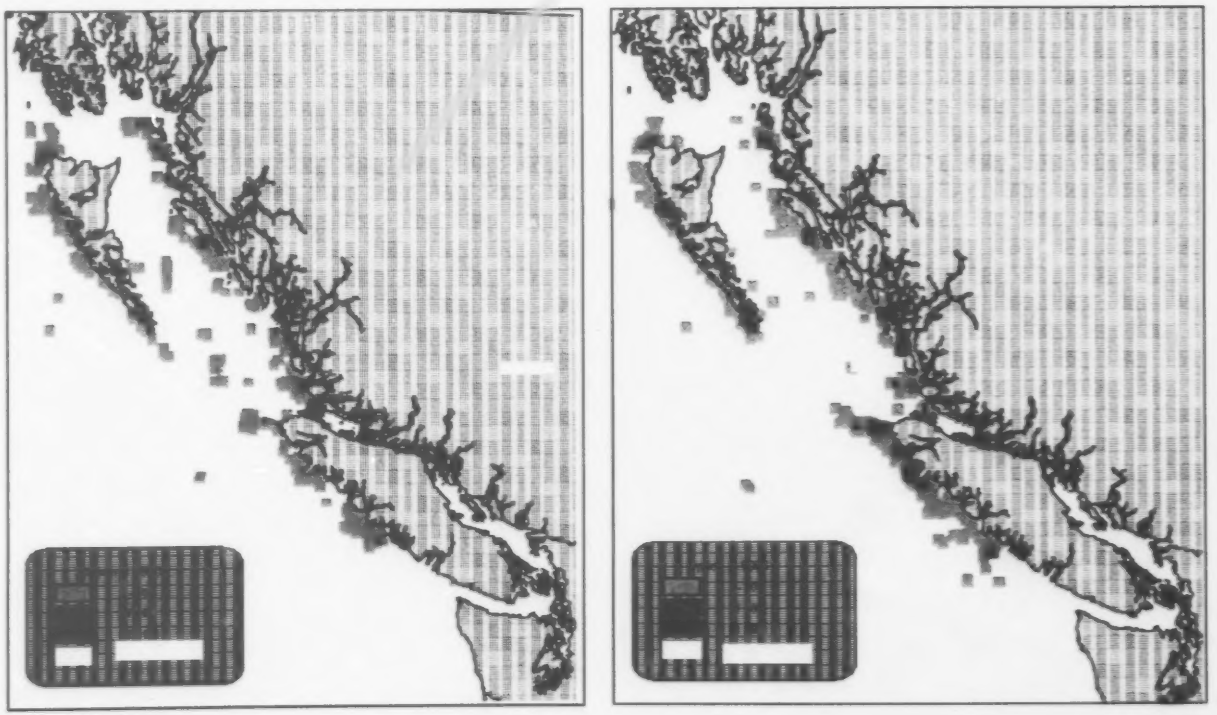

Figure 18b. Option B grouped numbers of fishing events by 2.7x 2.7 km grids by year.

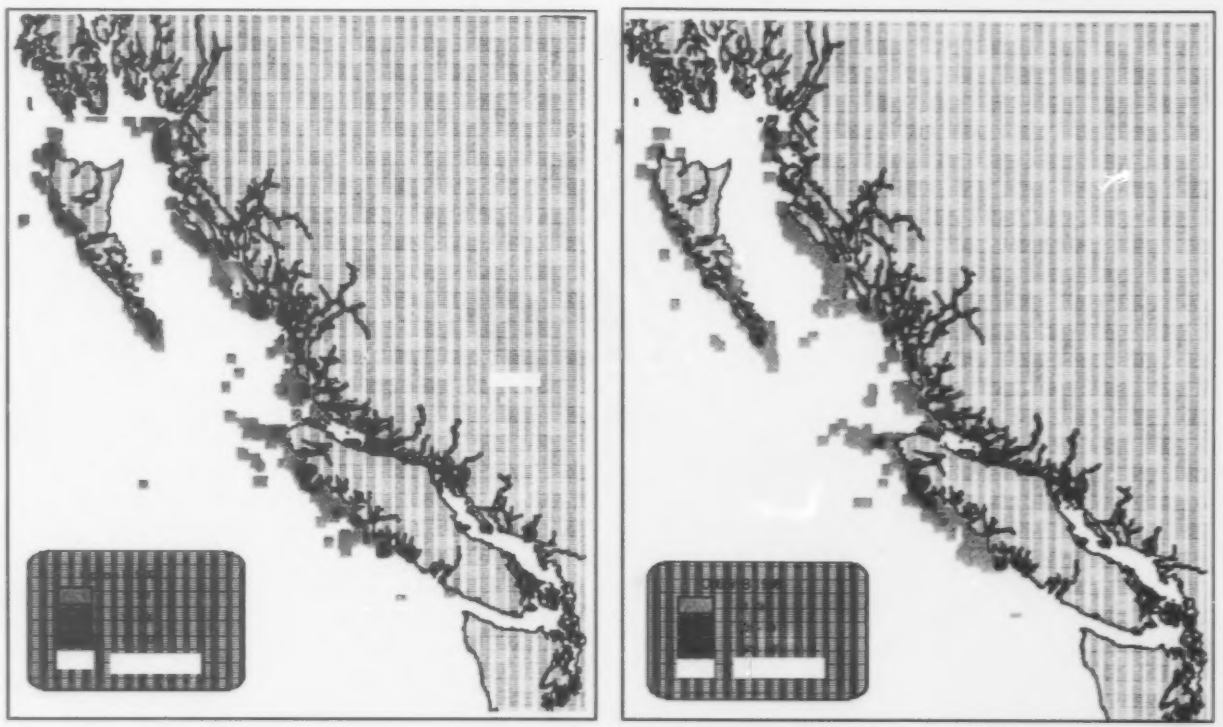

Figure 18c. Option B grouped numbers of fishing events by 2.7x 2.7 km grids by year.

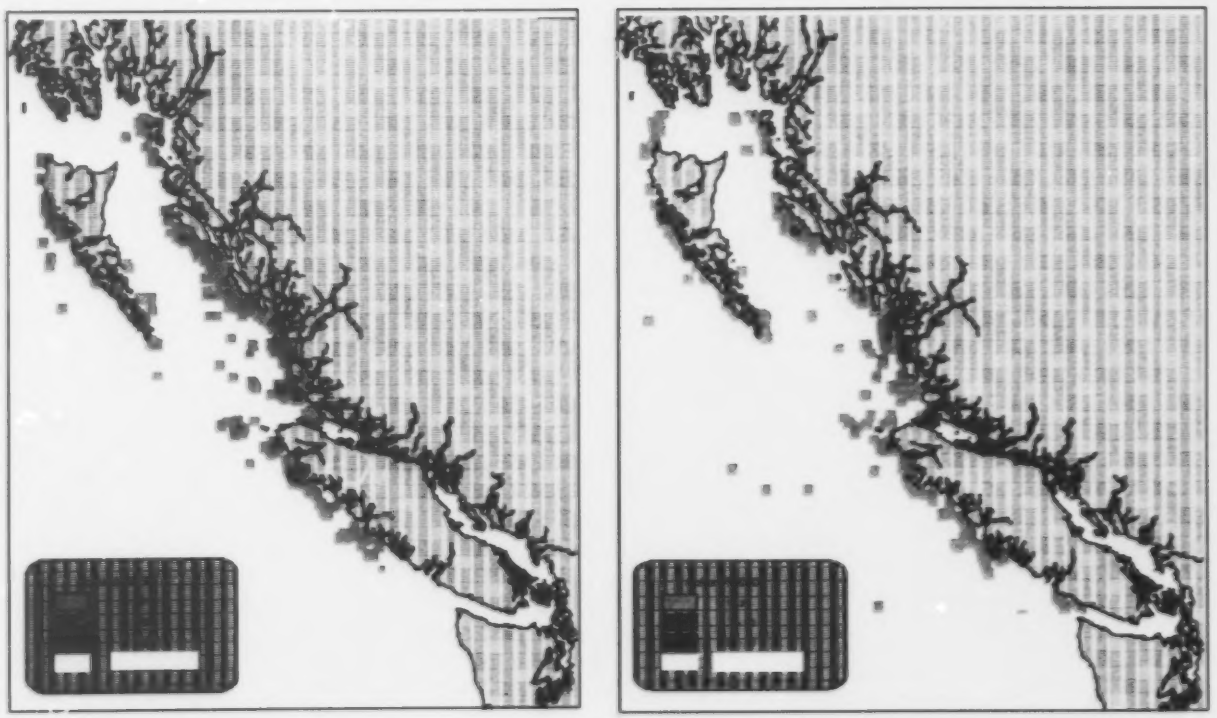

Figure 19. ZN option C (deep water rockfish) fishing effort (number of sets) summarized by year (a, b and c) in 2.7 square km grid cells in outside management areas.

Figure 19a. Option C grouped numbers of fishing events by 2.7x 2.7 km grids by year

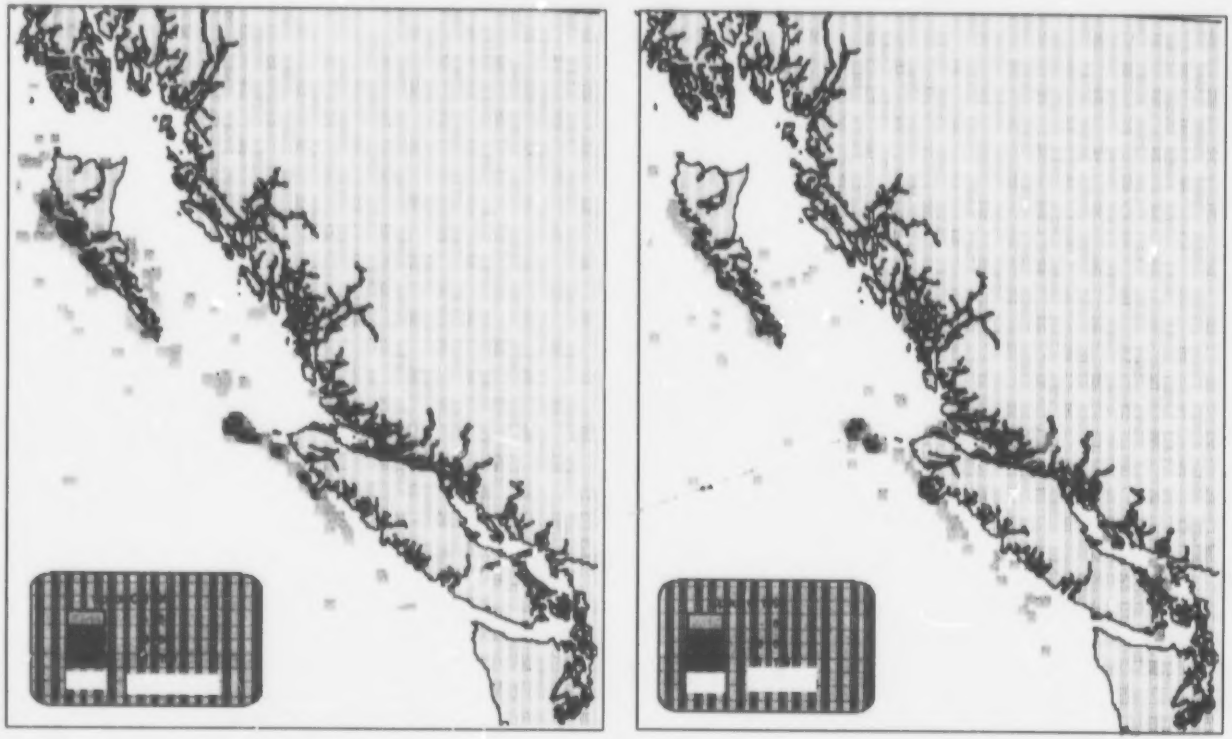

Figure 19b Option C grouped numbers of fishing events by 2.7x 2.7 km grids by year

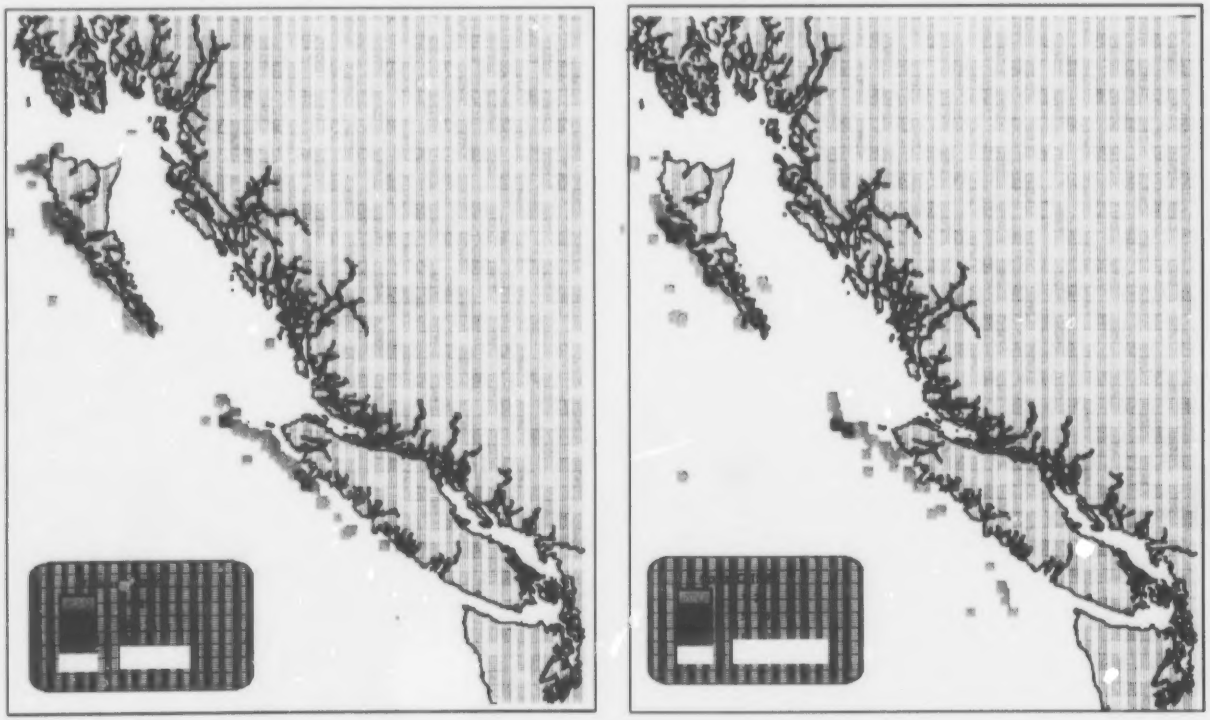

Figure 19c. Option C grouped numbers of fishing events by 2.7x 2.7 km grids by year.

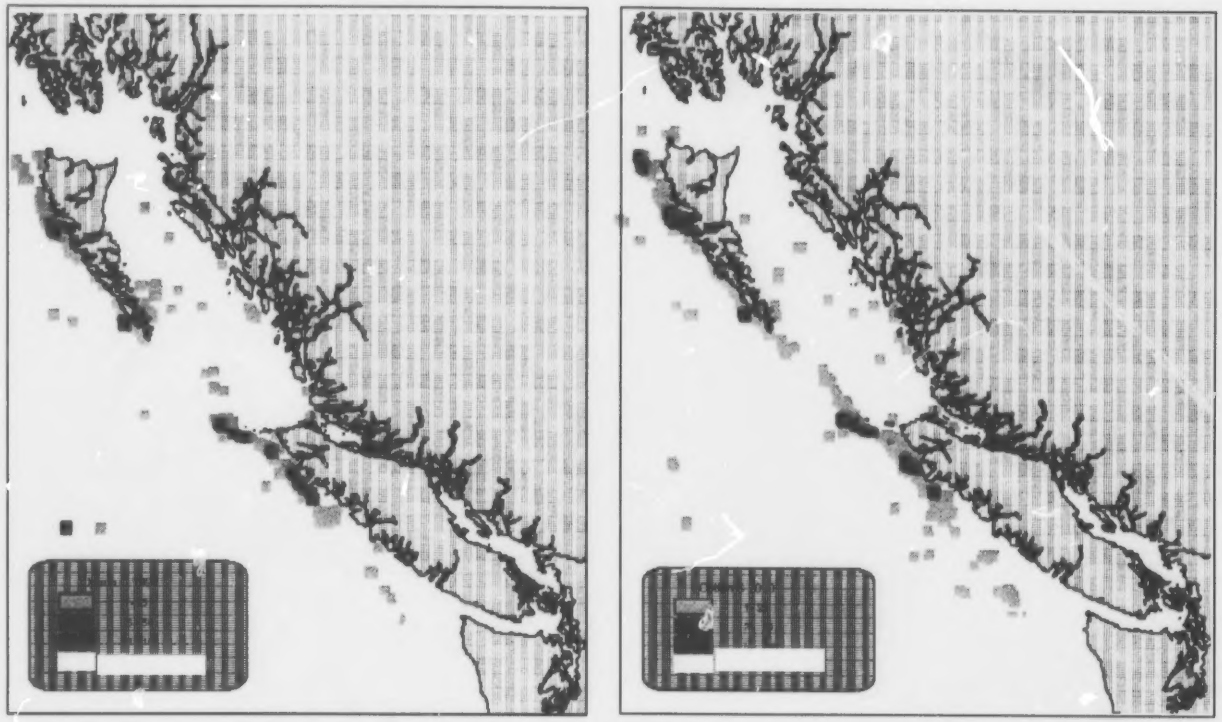

Figure 20. ZN option I (Strait of Georgia live rockfish) fishing effort (number of sets) summarized by year (a, b and c) in 2.7 square km grid cells in outside management areas.

Figure 20a. Option I grouped numbers of fishing events by 2.7x 2.7 km grids by year.

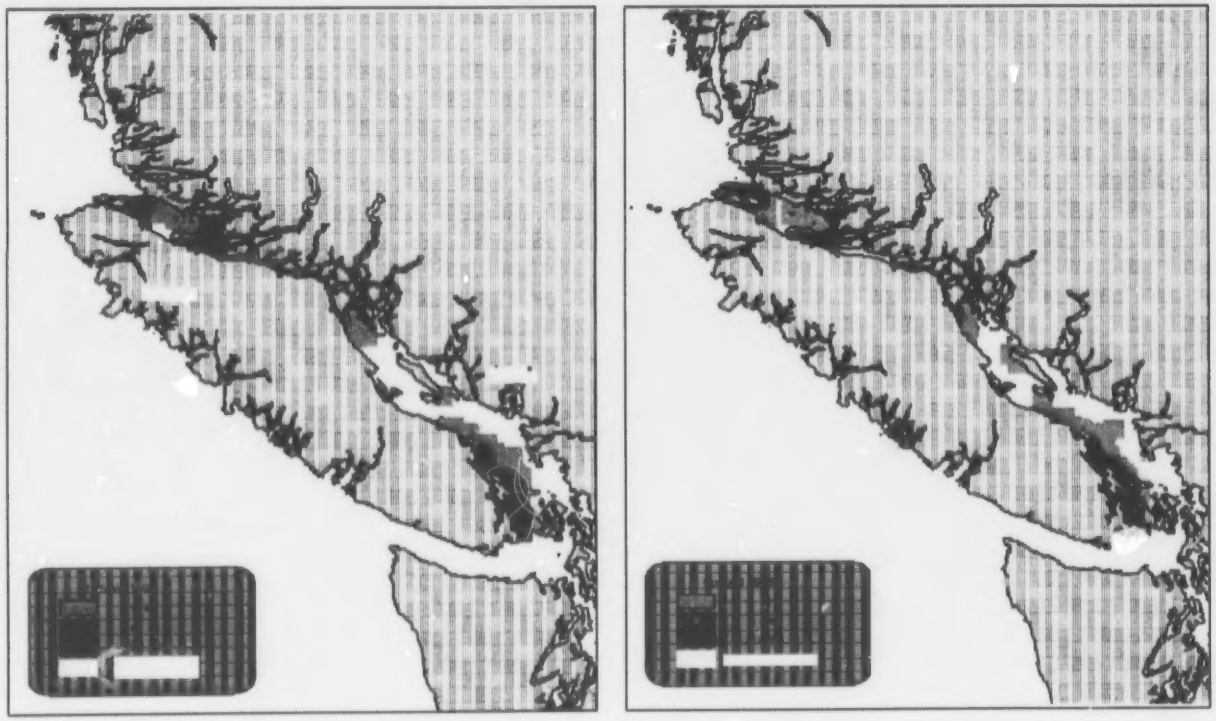

Figure 20b. Option I grouped numbers of fishing events by 2.7x 2.7 km grids by year.

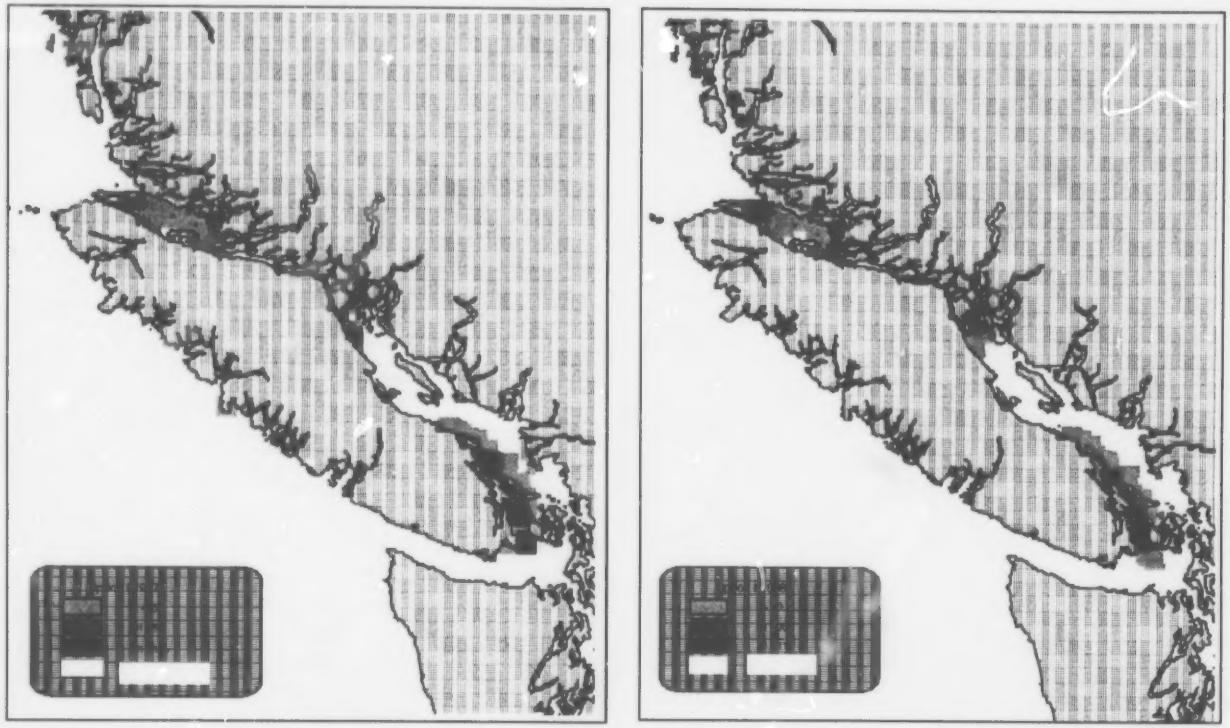

Figure 20c. Option I grouped numbers of fishing events by 2.7x 2.7 km grids by year.

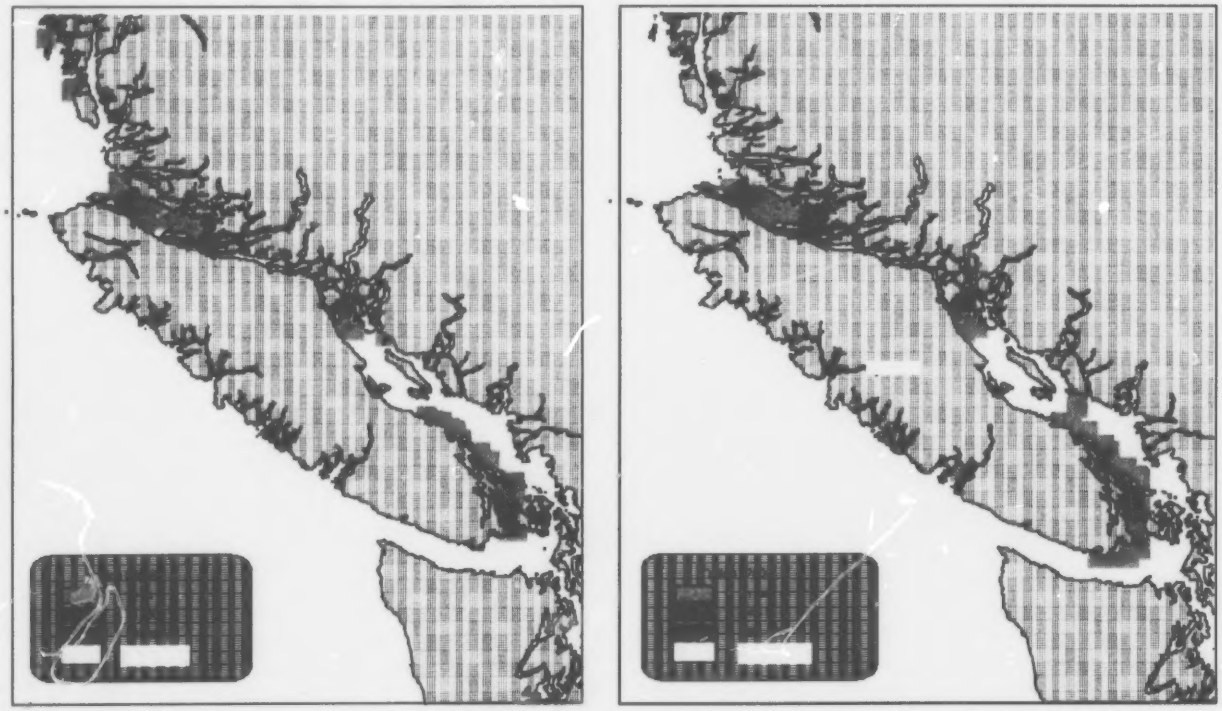

Figure 21. Recreational catch in numbers of rockfish per 10 boat trips during July to August 1982-2000 by PFMA from the Strait of Georgia Creel Survey.

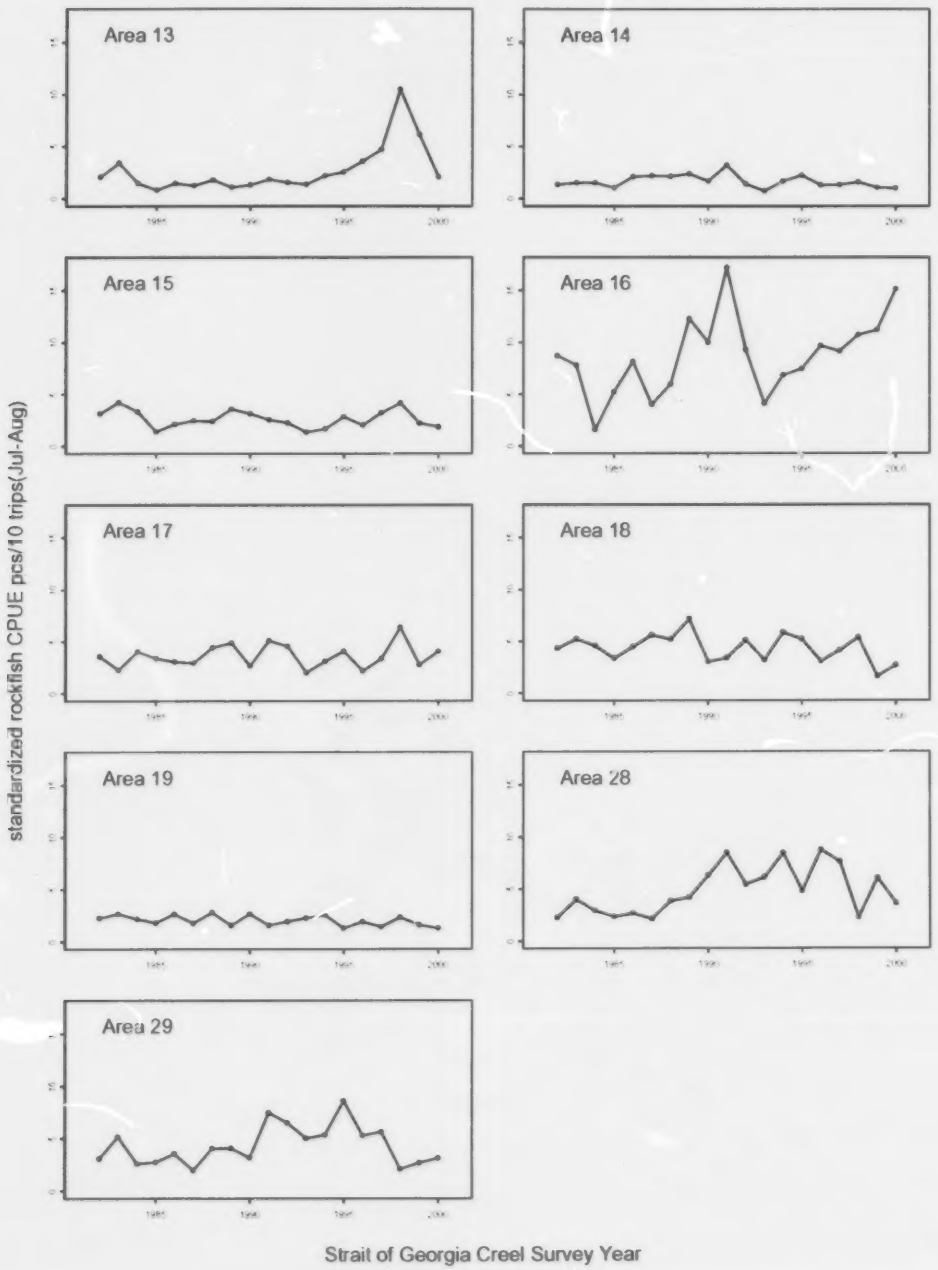

Figure 22. Research survey catch in number of rockfish per minute of angling by year and depth interval (left panels) and the corresponding catch age (right panels). Boxplots show the median, 1st and 3rd quartiles of the data.

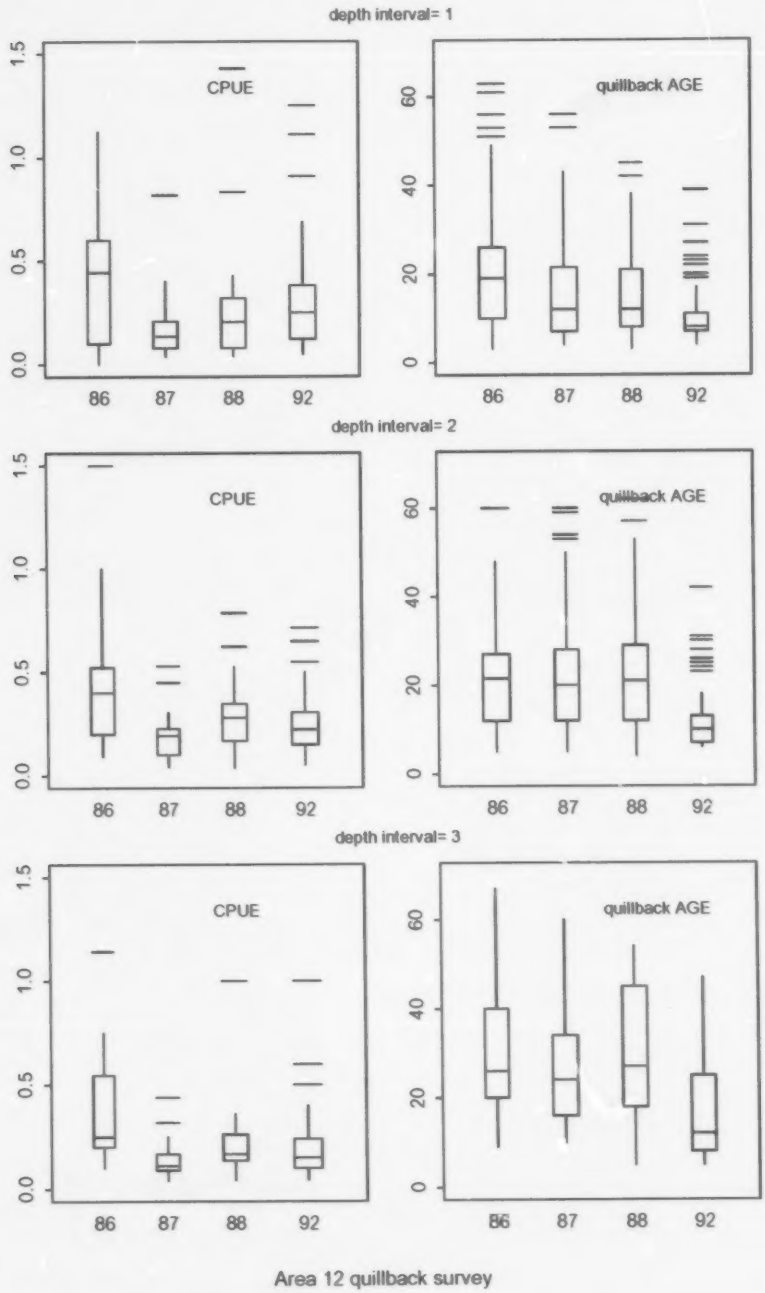

Figure 23. Yelloweye rockfish length at age and resulting estimates of von Bertalanffy growth parameters for males and females by index site.

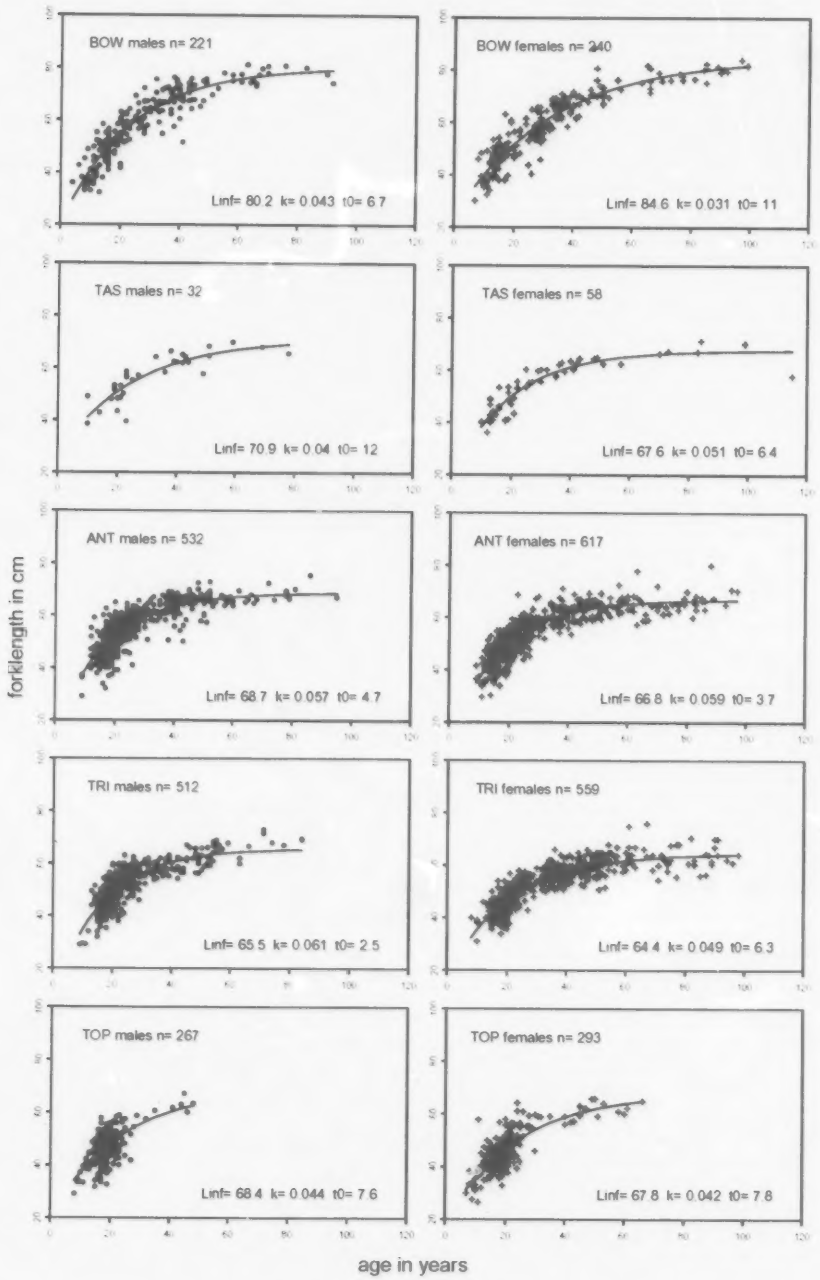
BOW males n= 221
Linf= 80.2 k= 0.043 t0= 6.7
BOW females n= 340
Linf= 84.6 k= 0.031 t0= 11
TAS males n= 32
Linf= 70.9 k= 0.04 t0= 12
TAS females n= 58
Linf= 67.6 k= 0.051 t0= 6.4
ANT males n= 532
Linf= 68.7 k= 0.057 t0= 4.7
ANT females n= 617
Linf= 66.8 k= 0.059 t0= 3.7
TRI males n= 512
Linf= 65.5 k= 0.061 t0= 2.5
TRI females n= 559
Linf= 64.4 k= 0.049 t0= 6.3
TOP males n= 267
Linf= 68.4 k= 0.044 t0= 7.6
TOP females n= 293
Linf= 67.8 k= 0.042 t0= 7.8
forklength in cm
age in years

Figure 24. Quillback rockfish rockfish length at age and resulting estimates of von Bertalanffy growth parameters for males and females by PFMA within the Strait of Georgia management region.

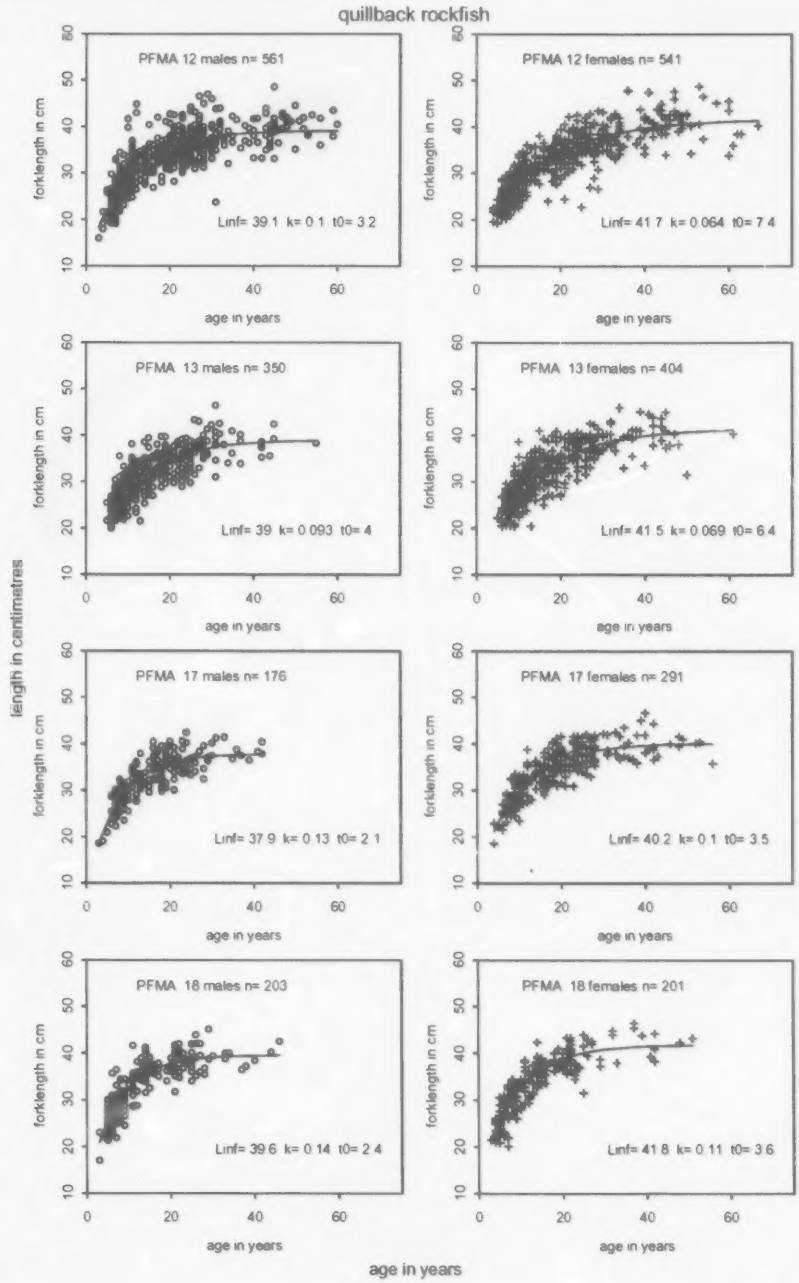
quillback rockfish
PFMA 12 males n= 561
Linf= 39.1 k= 0.1 t0= 3.2
PFMA 12 females n= 541
Linf= 41.7 k= 0.064 t0= 7.4
PFMA 13 males n= 350
Linf= 39 k= 0.093 t0= 4
PFMA 13 females n= 404
Linf= 41.5 k= 0.069 t0= 6.4
PFMA 17 males n= 176
Linf= 37.9 k= 0.13 t0= 2.1
PFMA 17 females n= 291
Linf= 40.2 k= 0.1 t0= 3.5
PFMA 18 males n= 203
Linf= 39.6 k= 0.14 t0= 2.4
PFMA 18 females n= 201
Linf= 41.8 k= 0.11 t0= 3.6
forklength in cm
age in years
length in centimetres
age in years

Figure 25. Male yelloweye rockfish age histograms (left panels) and catch curves (Ricker 1975) showing estimates of total mortality (Z) and mortality over the 21 to 60 age classes (Z_1) for Bowie Seamount and the index sites.

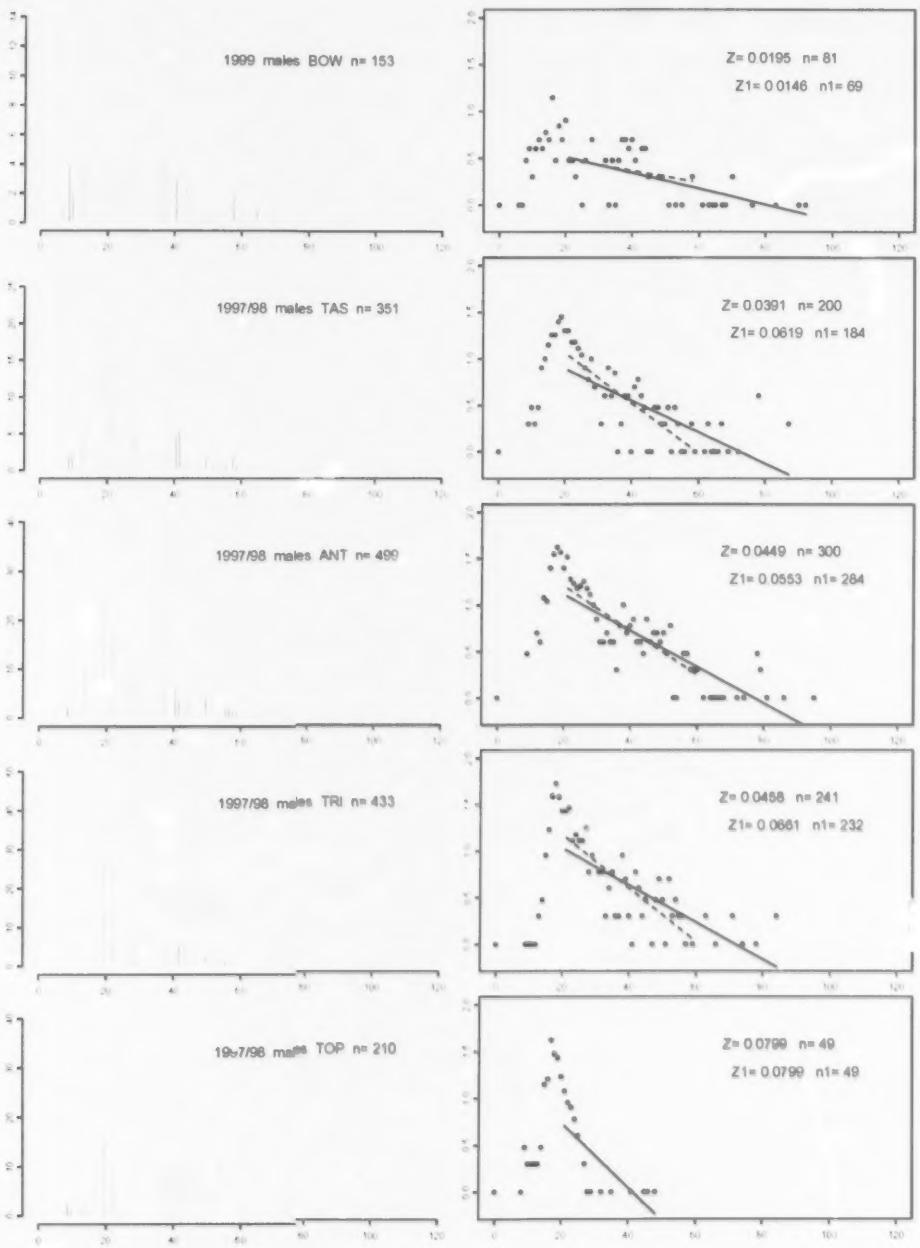

Figure 26. Female yelloweye rockfish age histograms (left panels) and catch curves (Ricker 1975) showing estimates of total mortality (Z) and mortality over the 21 to 60 age classes (Z_1) for Bowie Seamount and the index sites.

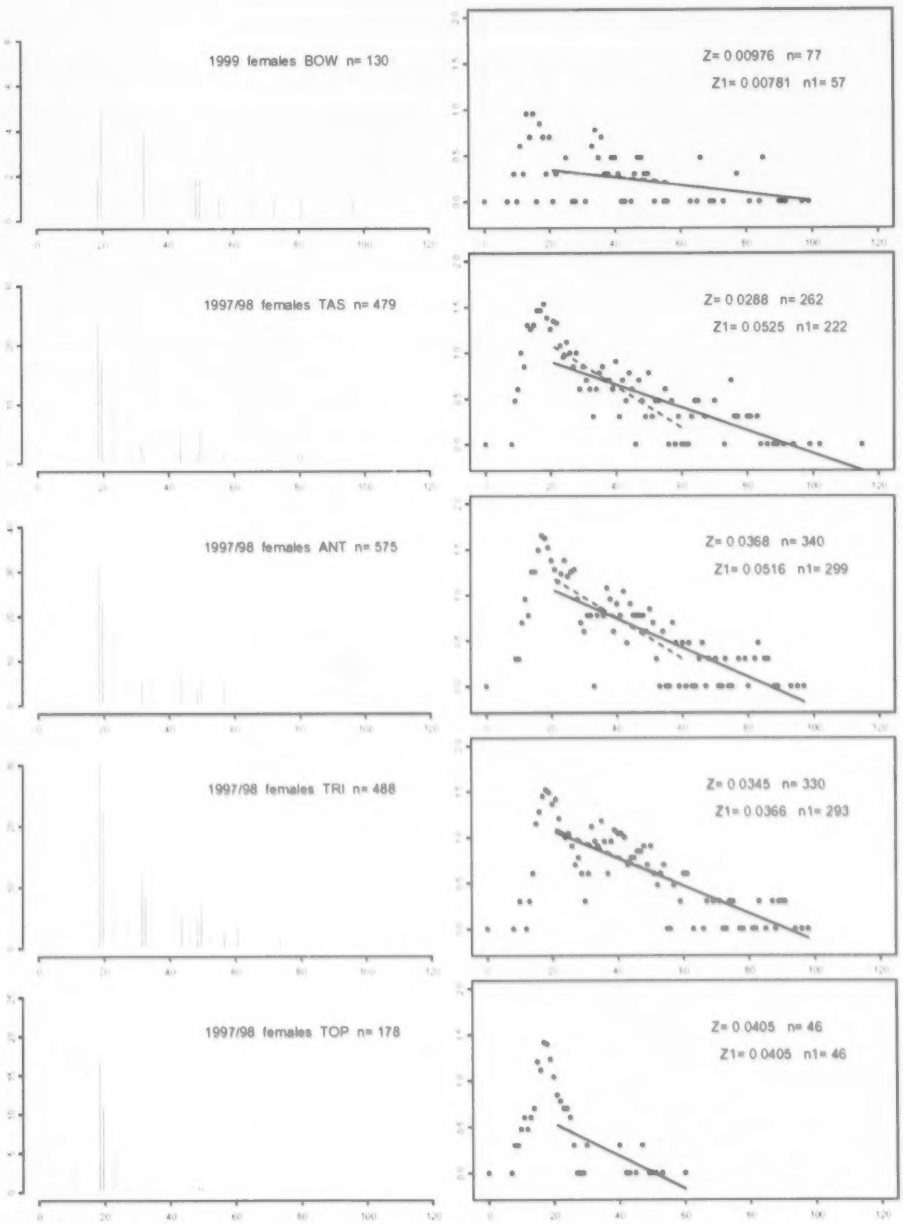

Figure 27. Male quillback rockfish age histograms (left panels) and catch curves (Ricker 1975) showing estimates of total mortality (Z) and mortality over the 12 to 40 age classes (Z_1) from research surveys in the PFMA 12 index sites by year.

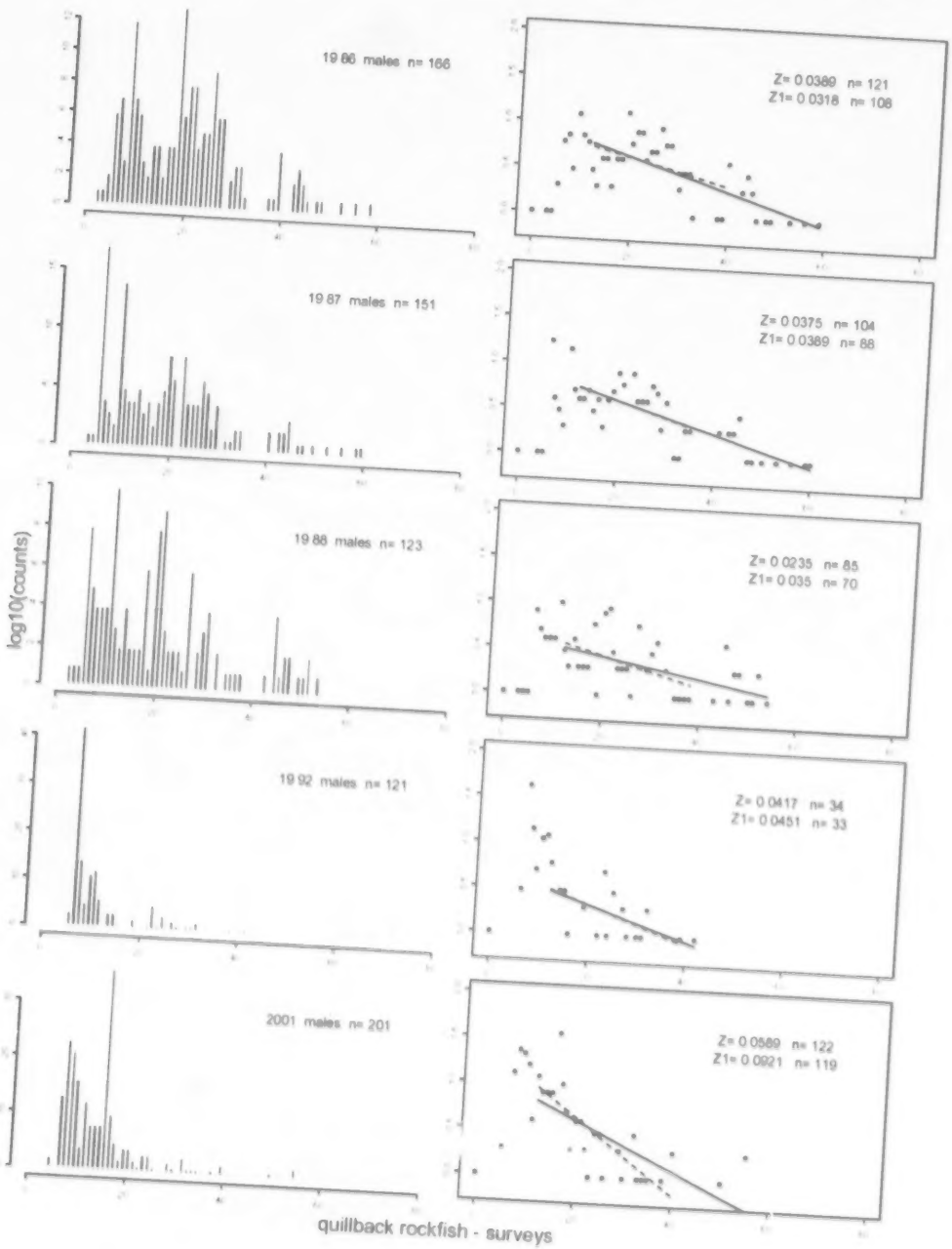

Figure 28. Female quillback rockfish age histograms (left panels) and catch curves (Ricker 1975) showing estimates of total mortality (Z) and mortality over the 12 to 40 age classes (Z_1) from research surveys in the PFMA 12 index sites by year.

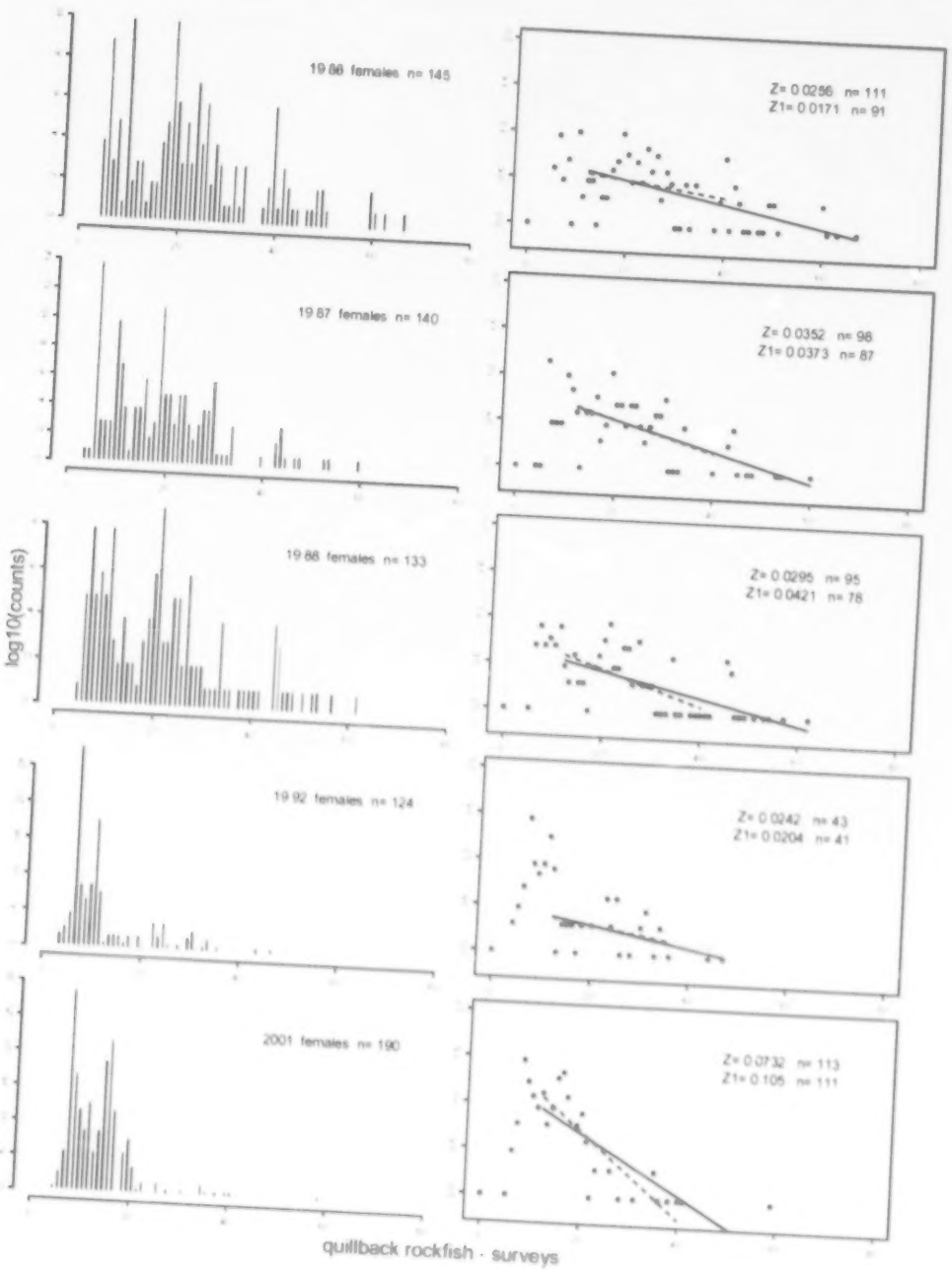

Figure 29. Yelloweye rockfish (sexes combined) age histograms (left panels) and catch curves (Ricker 1975) showing estimates of total mortality (Z) and mortality over the 21 to 60 age classes (Z_1) for the index sites and Bowie Seamount by year.

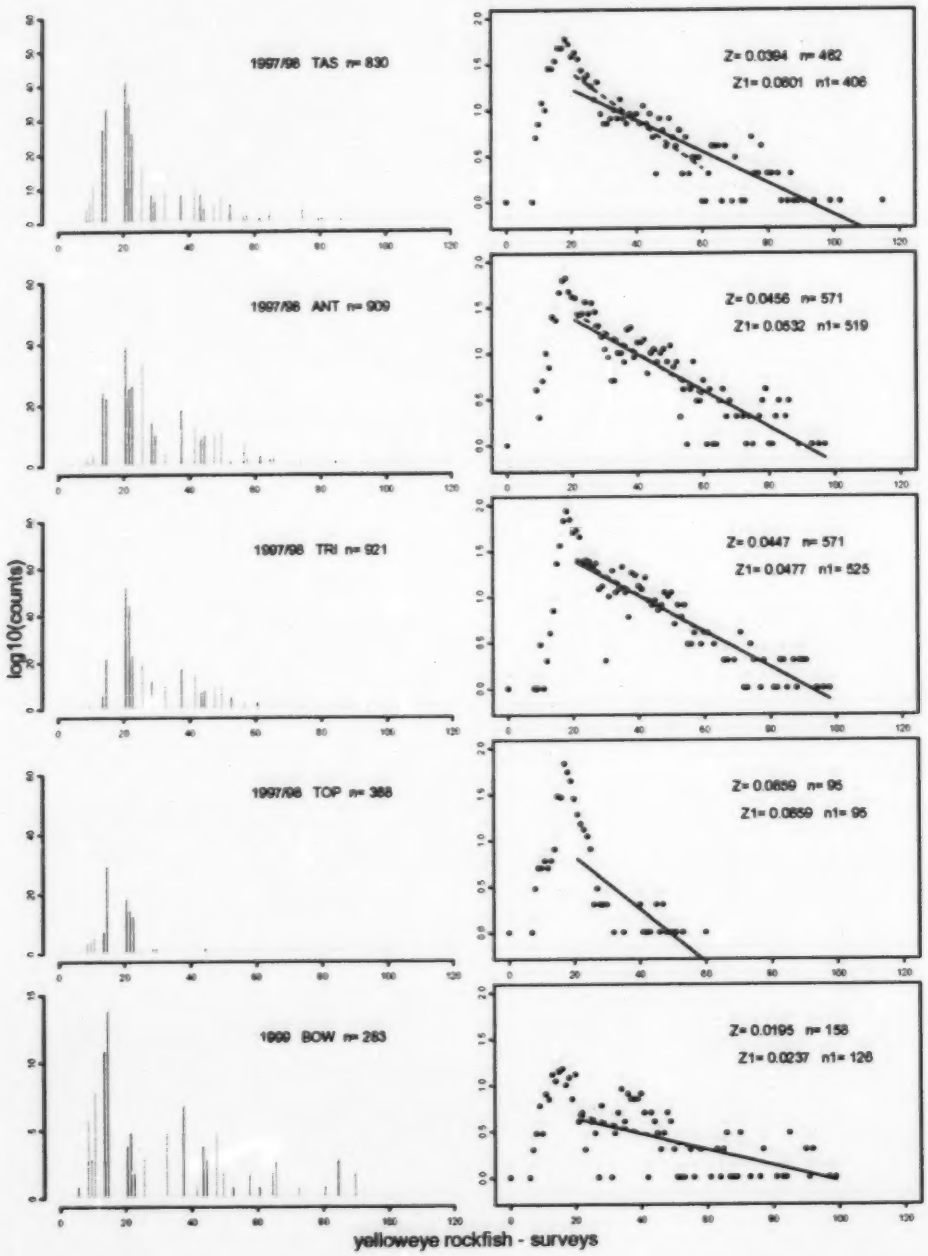

Figure 30. Yelloweye rockfish (sexes combined) age histograms (left panels) and catch curves (Ricker 1975) showing estimates of total mortality (Z) and mortality over the 21 to 60 age classes (Z_1) for the index sites and Bowie Seamount by year.

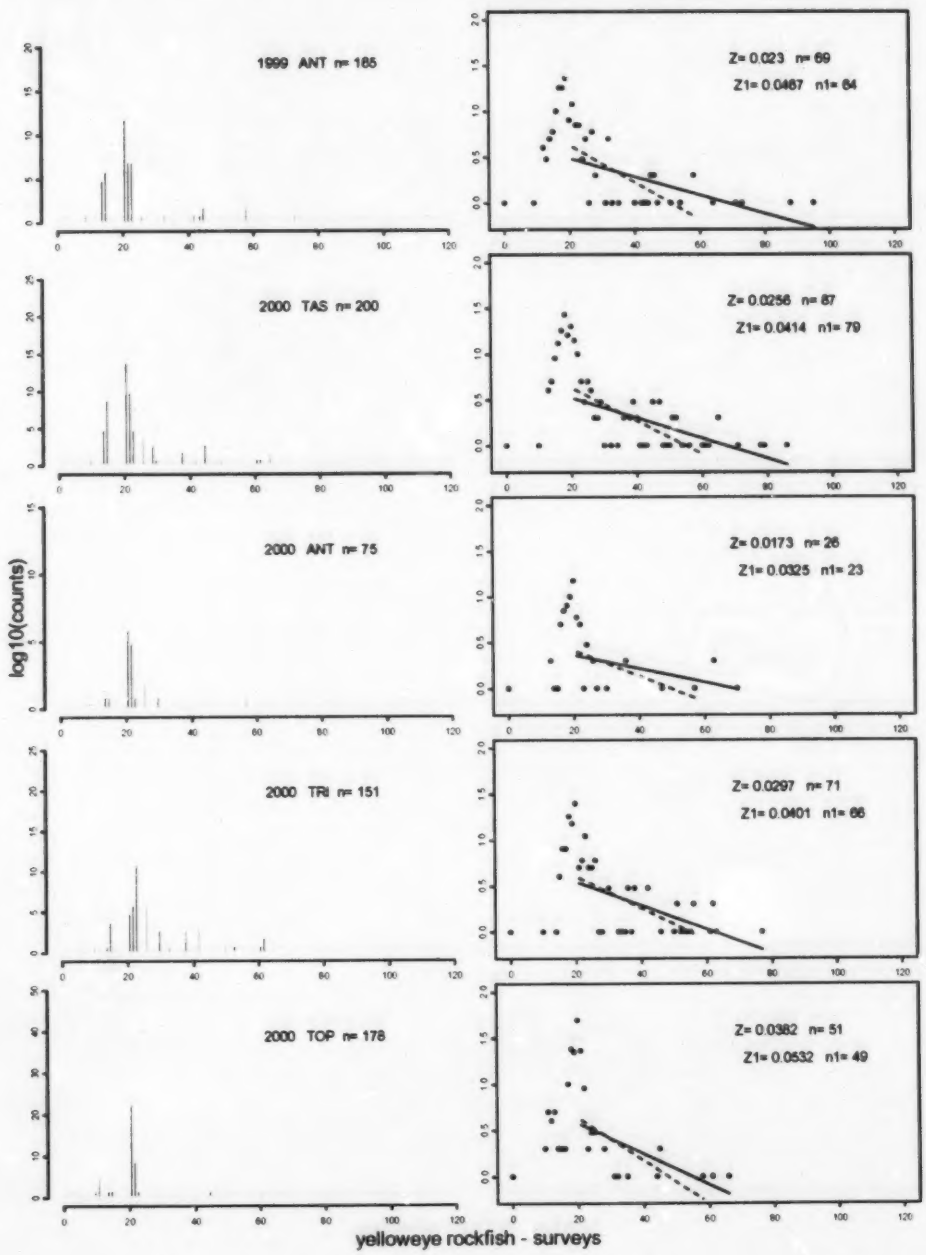

Figure 31. Quillback rockfish (sexes combined) age histograms (left panels) and catch curves (Ricker 1975) showing estimates of total mortality (Z) and mortality over the 12 to 40 age classes (Z_1) from research surveys in the PFMA 12 index sites by year.

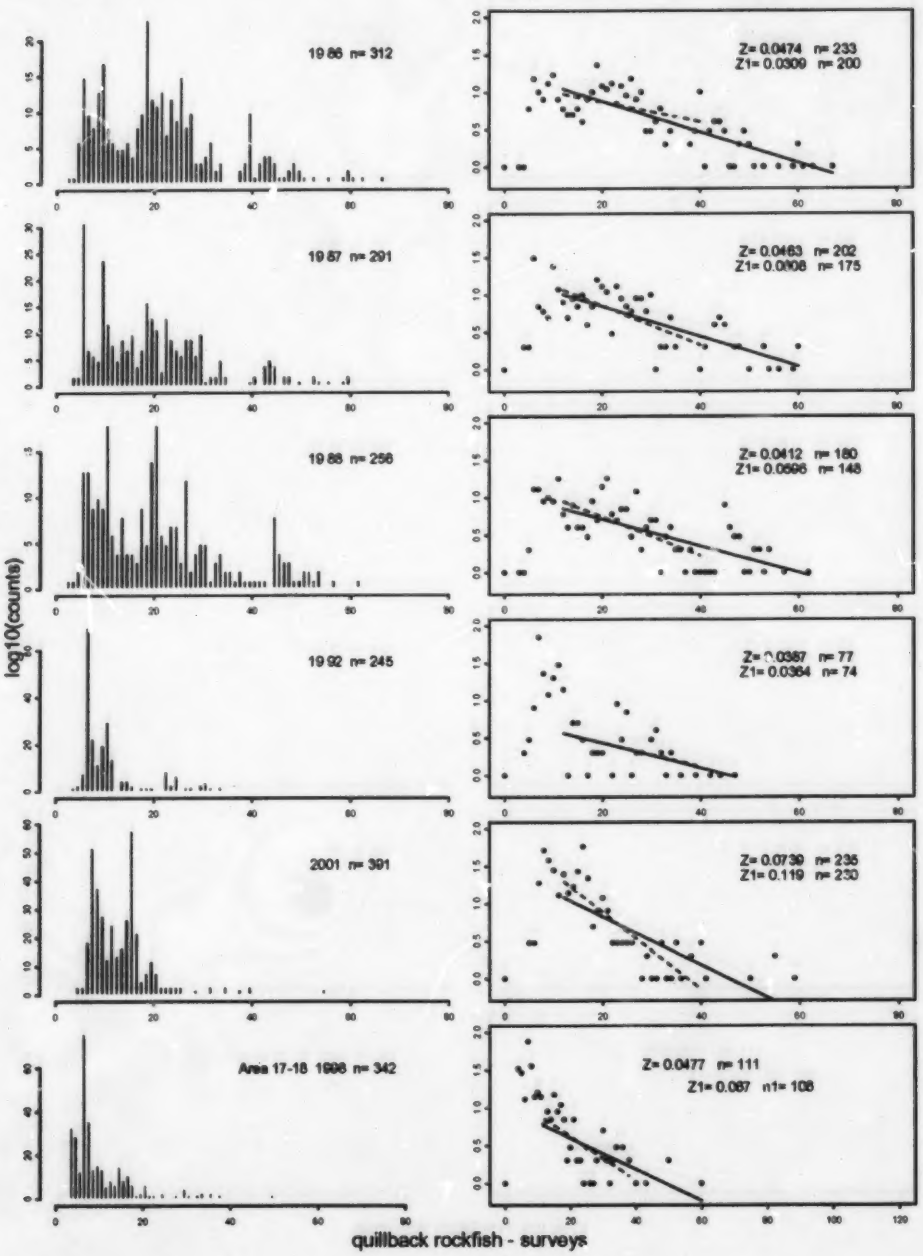

Figure 32. Quillback rockfish (sexes combined) age histograms (left panels) and catch curves (Ricker 1975) showing estimates of total mortality (Z) and mortality over the 12 to 40 age classes ($Z_{1\text{-}}$) from commercial samples by PFMA and year.

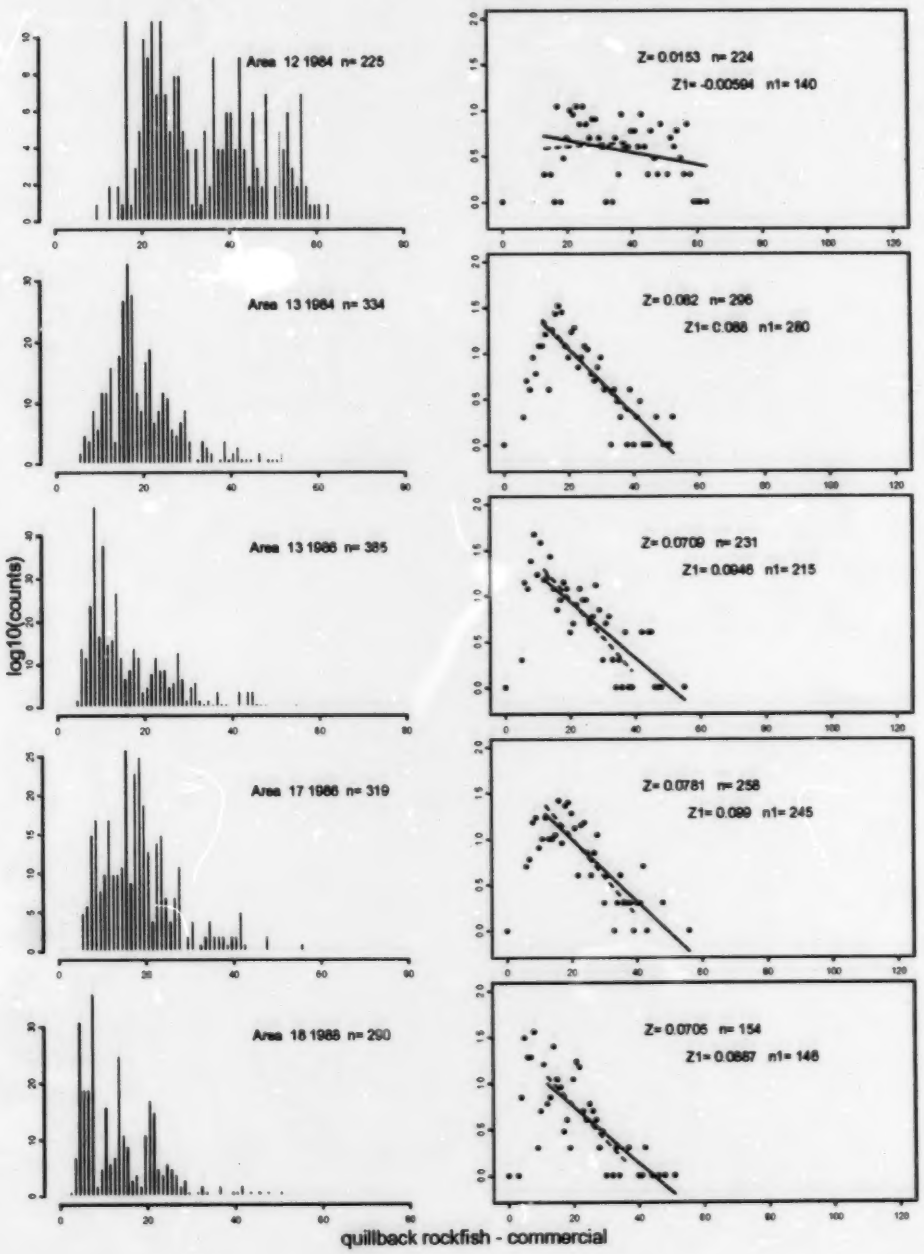

Figure 33. Yelloweye rockfish "relative" Z_1 plotted with annual estimates of catch in tonnes. Z_1 are shown as "X" from research survey data and "O" from commercial fishery samples, by area.

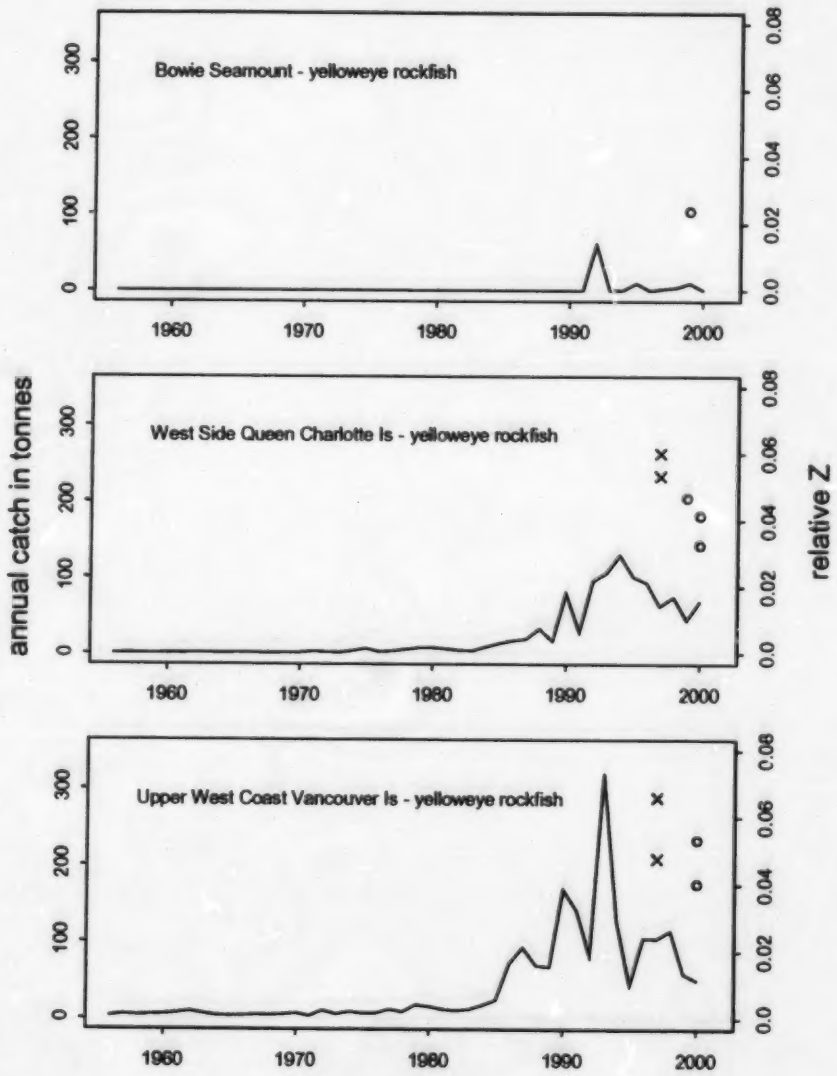

Figure 34. Quillback rockfish "relative" Z_1 plotted with annual estimates of catch in tonnes. Z_1 are shown as "x" from research survey data and "o" from commercial fishery samples, by area.

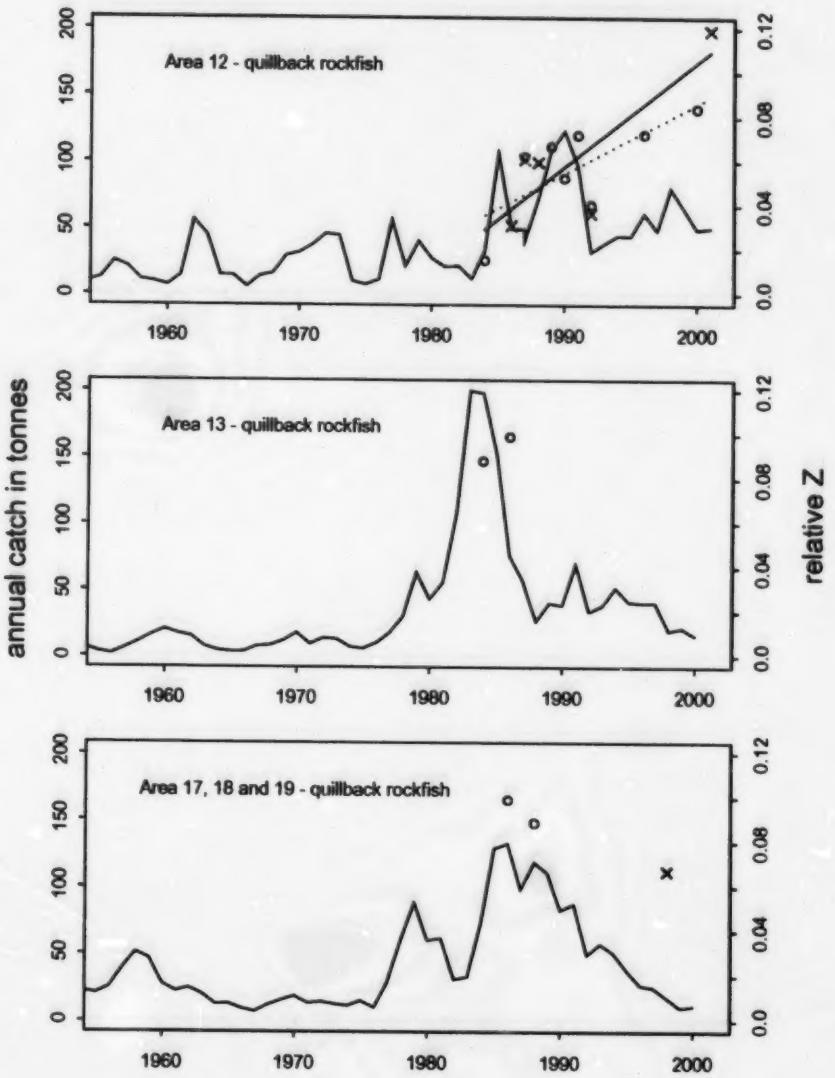

Figure 35. Neighbor-joining dendrogram of yelloweye rockfish samples based on Nei's (1972) genetic distance calculated from microsatellite allele frequencies.